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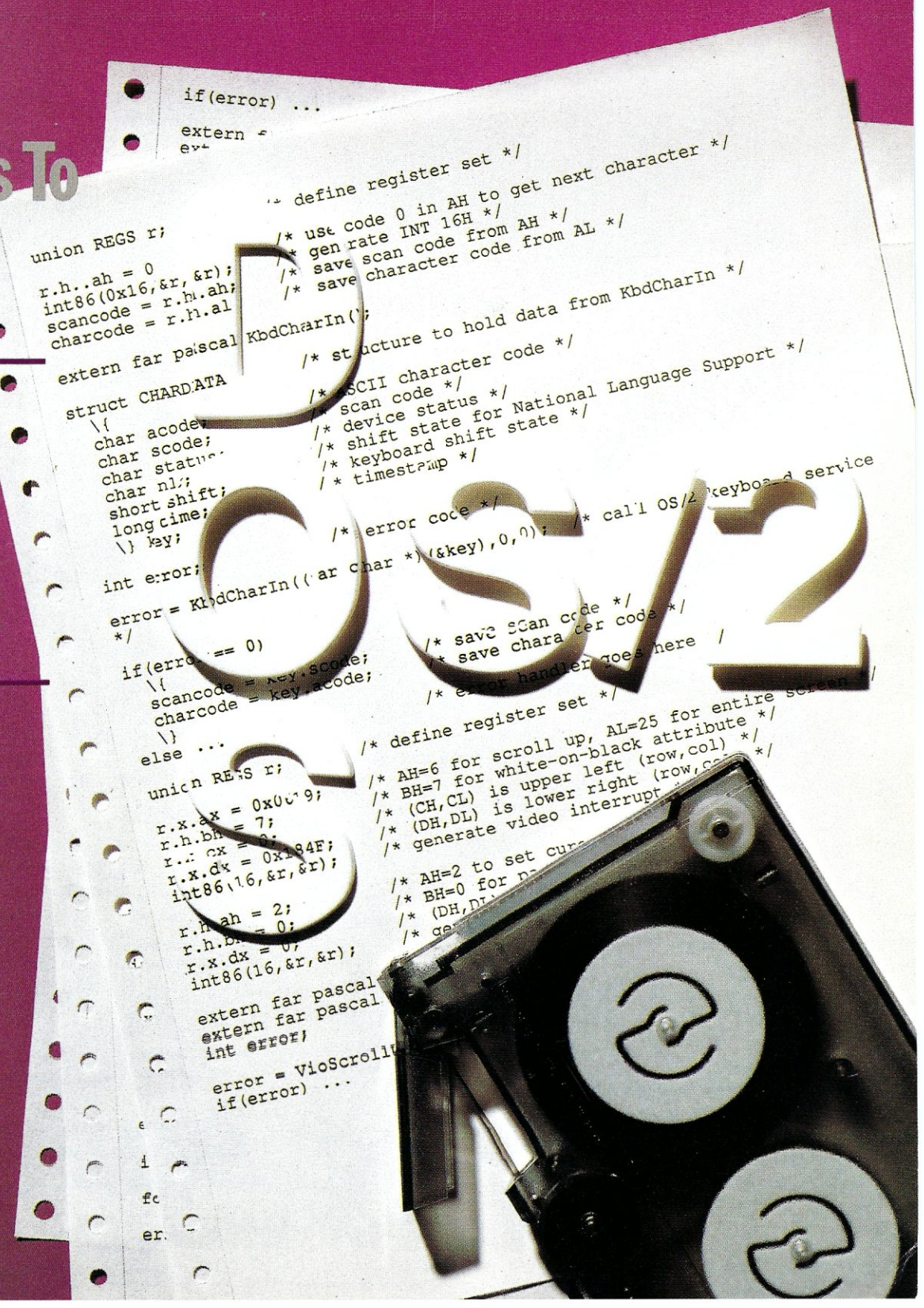

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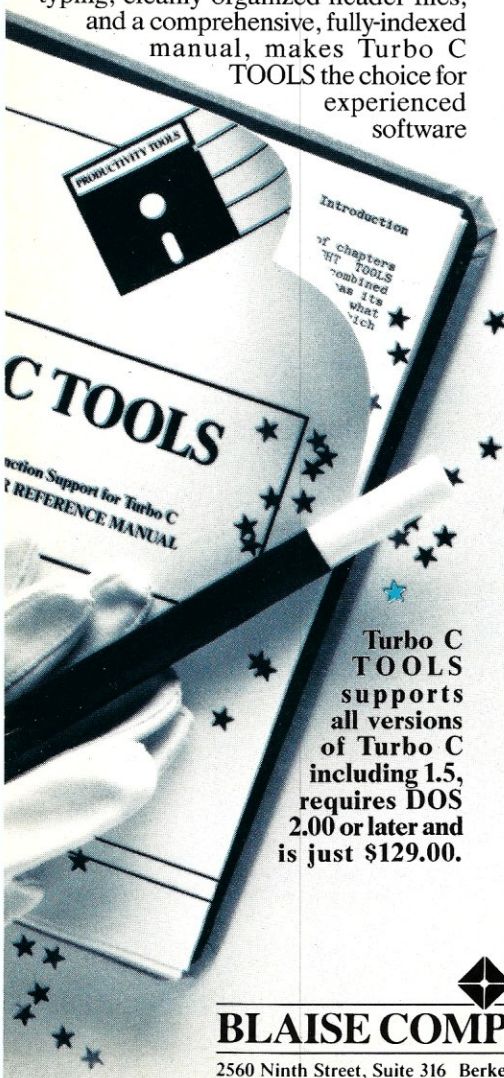

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March 1988
Vol. 4 . No. 3

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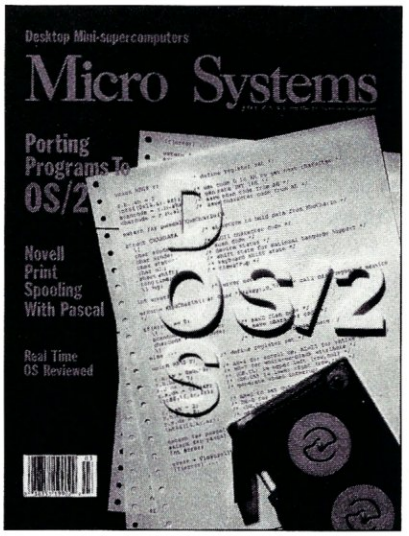

About the cover: The first version of IBM's Operating System 2 has finally arrived, and many programmers are busy porting DOS applications to run under OS/2's protected mode multiprocessing facility. In this issue, we present two articles to assist readers in preparing for the coming of OS/2.
Cover photograph by Michael Carr

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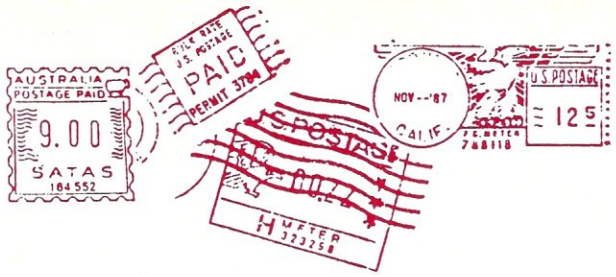

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DB-9 Serial Port Connector Clarified

Dear Editor:

I found your article "Dealing With the DB-9 Serial Port" (*M/SJ*, November/December 1987) interesting and informative, but slightly in error.

When dealing with "S-sub" connectors, the letter immediately following the "D" denotes the connector shell size and the last letter in the description denotes the "sex"—"P" for plug and "S" for socket. Contrary to IBM's own documentation they do not use a "DB-9" but use a "DE-9P" on their systems. I believe it almost impossible for anyone to find a "DB" connector with only 9-pins that will mate with IBM's 9-pin connector.

The standard connector configuration is "DE-9P" for a male connector, and a "DE-9S" for the female connector. "DB-9P" and "DB-9S" are also valid.

Also, according to my schematics, you have pins 2 and 3 swapped as to which is input and which is output. Pin-2 should be the RxD input and Pin-3 the TxD output. Remember, IBM likes to configure its systems as DTE devices.

Bruce D. Fischer, Engineer
Altos Computer Systems
Newark, Calif.

From The Editor:
My apologies. Bruce is correct in that the functions of pins 2 and 3 on the IBM serial interface DB-9 connector are just the reverse of their functions on IBM's serial DB-25 connector. IBM is noted for not being consistent in designating connector pin functions.

Wait States & Refresh Explained

Dear Editor:

I believe that Jeff Duntemann is in error concerning his discussion of the concepts of "wait states" and "refresh" ("Intel's iSBC 386AT," *M/SJ*, November/December 1987). His statement, "Once you read data from a DRAM, you must allow a period of time to pass before reading it again to refresh it at least once between reads," is erroneous.

Wait states are needed with any microprocessor when its clock rate is high enough, so that the time from valid memory address to data in/out is less than the access time of the memory chip. This access time is independent of the type of RAM being used. It is the same for static RAM as it is for Dynamic RAM.

Refresh means that each "row" of a RAM memory array must be addressed within a certain period of time or the memory circuits will lose their data. This is usually 10–100 milliseconds for all row addresses to be accessed. Usually, the circuitry that generates the refresh cycles are buried within the microprocessor or memory control hardware.

I hope that this explanation clarifies the difference between these two parameters.

Arnold S. Berger, PhD
R & D Project Manager
Hewlett-Packard Corp.
Colorado Springs, Colo. □

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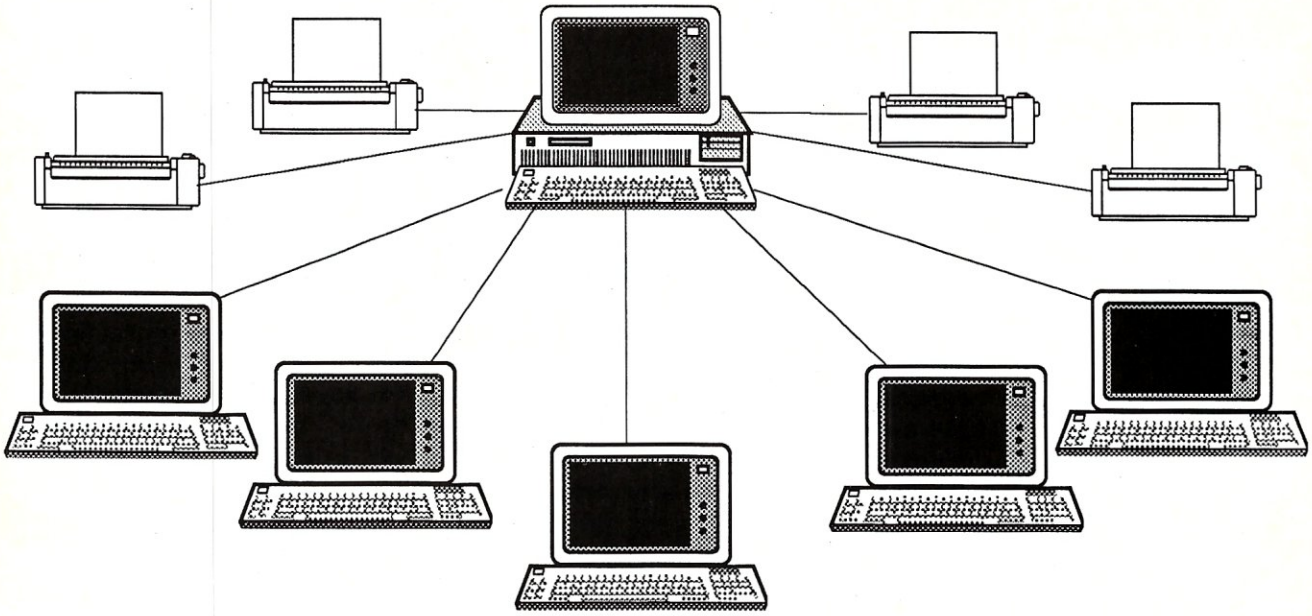

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From The Editor's Desk

by Sol Libes

OS/2 Has Arrived! Or Has It?

OS/2 is here, but the question is who is buying it? IBM began shipping OS/2 Version 1.0 in early December, and Zenith started shipping soon after. Compaq and Wyse Technologies will also make implementations for their 286 and 386 based systems available in the immediate future. However, most other system manufacturers are currently adopting a wait-and-see posture. At some point, however, all computer companies will be offering OS/2 as an option while bundling DOS with most systems.

There is no software currently available that takes advantage of OS/2-enhanced features, such as multitasking. Most current applications are merely ports of software already running under DOS. And there is a strong likelihood that we will not see any really worthwhile OS/2 applications until OS/2 Version 1.1 containing the Presentation Manager is released in the fall.

So who is buying OS/2? Mostly software developers and users taking advantage of IBM's $200 upgrade for owners of PC-DOS 3.x (the regular price is $325). It is estimated that there are more than 3,000 programmers actively working on OS/2 application software. This large number of software developers is bound to produce some worthwhile OS/2 application products, and these products should begin to appear very late this year, with market momentum building in 1989 and 1990.

Sales of 286-based systems have already exceeded those of 8088/8086-based systems, and sales of the latter are expected to begin tapering off gradually. Some time in the early 1990s, sales of 386-based systems will also probably exceed those of 8088/8086-based systems, and the 386 is really the performance platform needed for OS/2.

The question is, which 286/386 operating system will dominate? Will it be OS/2, a new version of DOS with Windows, or UNIX with Xwindows? And what about all those operating systems, like PC/MOS-386, Concurrent DOS, Theos, and Pick?

One thing is for sure, we are in for interesting times and *Micro/Systems Journal* will be here to guide you through the changes. □

Sol Libes

News & Views

Random Rumors & Gossip

IBM and **Microsoft** are expected to release one or more new versions of DOS this year. The new DOS generation(s) will add several new features, among them a new user interface, hard disk storage greater than 32 MB, limited multitasking via special software drivers, and built-in support for memory greater than 640K via the Lotus/Intel/Microsoft Expanded Memory Specification (LIM EMS Version 4.0). Some of these features have already been implemented on versions of DOS offered by Compaq, Zenith, and other system manufacturers.

IBM's first PS/2 plug-in card utilizing the multimaster feature of the Micro Channel Architecture (MCA) is expected to become available shortly. Rumors are that it will be an RT RISC coprocessor card for the Model 80. It takes over the MCA, relegating the 386 to the role of an I/O processor. IBM is expected to follow this with a 360 multimaster-type coprocessor card. The question is whether IBM will sell these as add-in cards or as complete systems.

Dataquest, a respected market researcher, estimates that by the end of 1987 there were 12 million PC clones installed worldwide. Add that to about 8 million IBM PCs and you get about 20 million machines in operation. This figure is expected to double by the end of next year.

AT&T and **Sun Microsystems** have disclosed that they are jointly developing a new version of UNIX that will have real-time capabilities, concurrency, fault tolerance, parallel processes, and contain various security features.

Prices of modems using the CCITT V.32 9,600 kbps standard are coming down as more manufacturers enter this market. **Universal Data Systems** now sells a basic V.32 modem for a list price of $1,595. Multispeed operation and other features increase the cost. Non-compatible 9,600-baud modems from vendors such as **Hayes** and **U.S. Robotics** are in the $1,000 to $1,200 range.

Intel reports that demand for its 80386 microprocessor has grown at a much faster rate than company executives had originally projected, and that it has already been designed into 400 products. Intel now has four 386 production lines and is still backordered. However, there are whispers emanating from several IC houses that they will soon introduce RISC processor 80386 clone chips.

Microsoft is rumored readying a Macintosh coprocessor card that supports OS/2.

Sharp is the first company to go into actual production on an erasable optical drive, the JY-500. Sharp's JY-

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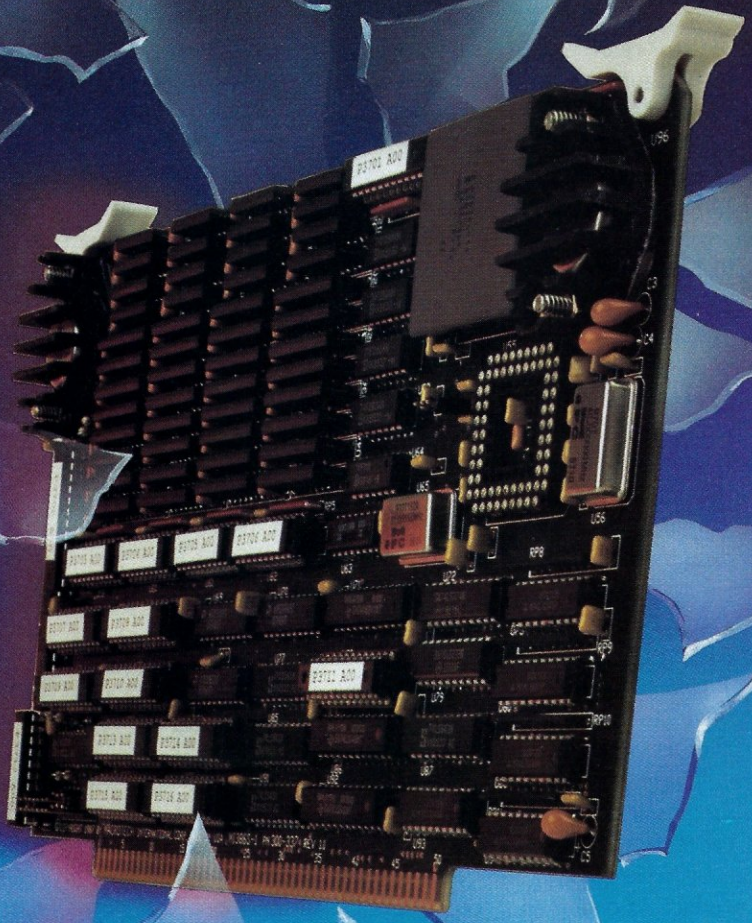

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500 uses a 5¼-inch removable disk cartridge storing 422 MB. The drive costs $12,000 and the disks are $675 each. It is rated for 1 million erasure/rewrite cycles over 10 years.

Apple Rumors

Apple is expected to release its UNIX operating system for the Mac II very soon, about six months later than promised. Called "A/UX," it is expected to sell for about $1,500 and be a System V implementation with 4.2 BSD extensions.

Apple has also disclosed that it has begun work on a new Mac operating system to be released in about three-to-four years. Aimed at competing with IBM's OS/2 Extended Edition, the new operating system is expected to include communications facilities, networking support, basic database facilities, multitasking, and demand-paged virtual memory.

Laser Printer Output Improving

More than one Japanese manufacturer is working on 1,200 dpi (dots-per-inch) laser printers with Postscript interfaces. These machines will produce quality output comparable to standard typesetting. Prototypes have already been shown in Japan with initial production expected to begin next year. And there are rumors of laser printers being developed that are capable of producing 2,000 dpi.

In the meantime, low-cost 450 dpi and 600 dpi laser printers with Postscript interfaces will begin to be shipped later this year. These will offer a significant increase in print quality and will no doubt lead to an increased use of laser printers for work previously done by typesetters. The introduction of the low-cost 450 and 600 dpi laser printers will no doubt cause 300 dpi machine prices to drop to well under $1,000. At the same time, the retail price for 300 dpi printers with Postscript and full-page graphics will probably drop to under $2,000.

PS/2 Sales Report

One noted market research group has reported that sales for PS/2 systems for the last quarter of 1987 broke down as follows:

Model 25	5 percent
Model 30	41 percent
Model 50	39 percent
Model 60	14 percent
Model 80	3 percent

This represents a dramatic increase in sales of the Model 50 compared to the Model 30, which represented most of IBM's PS/2 sales in the preceding quarter. The model 50 is IBM's lowest cost system capable of running OS/2.

There are many reports that IBM's PS/2 systems are being widely and heavily discounted by dealers and that most systems are readily available in the gray market. Discounts as high as 37 percent have been reported for the models 30 and 50 as dealers are attempting to move a large number of systems from inventory.

Good For The Gander

NEC recently sued **Seiko-Epson** for copying the BIOS in the NEC 286-based PC. They settled out of court, with Epson agreeing to pay an undisclosed sum to NEC and not to market the systems at issue.

It is worth noting that while NEC sued for ROM software copyright protection in a Japanese court, they argued in a U.S. court case, where they were being sued by Intel, that microcode stored in a microprocessor should not receive copyright protection.

NEC dominates the personal computer market in Japan with an estimated 80–90 percent of the 286-based market. □

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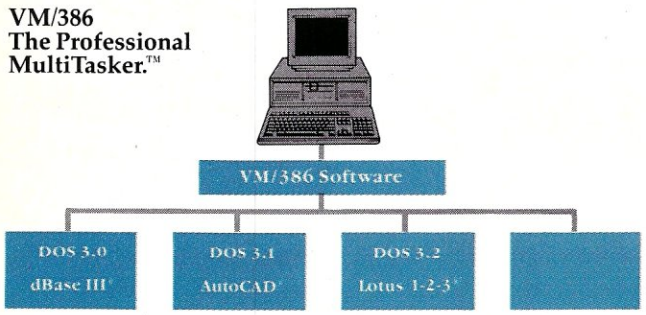

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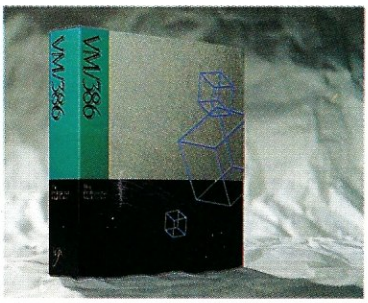

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IGC

by Don Libes

Pointers to Functions

This column features tips and techniques for using the C programming language productively. Typical problems encountered in using C are discussed, and solutions offered. Readers who have suggestions, comments, and questions are encouraged to contact C Forum, Micro/Systems Journal, *Box 1192, Mountainside, NJ 07092.*

The last C Forum, "Dump from the Hip" (*Micro/Systems Journal*, February 1988) offered a simple tool that was able to take input from either memory or a file. In order to do that cleanly, we used "function parameters."

In this column, I am going to discuss function parameters in more detail. First, I will point out the most common mistake made in trying to pass functions as parameters. Namely, functions cannot be passed, only "pointers to functions" can be. Thus, the declaration

```
subr(fun)
 int fun();
```

will not work. The declaration of *fun()* says that it is a function returning an *int*, but we are not allowed to pass functions as parameters (my compiler says, "Warning: a function is passed as an argument").

What we want is to pass a pointer to a function.

```
subr(fun)
 int (* fun)();
```

fun() is now declared as "a pointer to a function returning an *int*." This is read "inside out" (Listing 1).

More complex function declarations are constructed in the same fashion. *cdecl*, a program that converts declarations from C to English, and vice versa, may also help (see "C Forum," *Micro/Systems Journal*, January/February 1987).

When calling, we supply *subr()* with a parameter simply by naming a function. The compiler arranges for the address of the function to be passed when it sees a function name; the & is not necessary.

To use the parameter while inside of *subr()*, we dereference *fun* using *, then treat the result as a function. In other words, give it a set of parentheses with arguments. For example, to call the function (passed to *subr()*) with arguments 17 and "hello world" we would say

```
foo = (*fun)(17,"hello
    world");
```

Notice that the usage looks just like the declaration we made earlier.

Last month's column presented a program doing exactly what we have just discussed. The function *real_dump()* was defined, which took a function parameter. *real_dump()* was declared as shown in Listing 2. This allowed us to read input from either a file or memory, depending entirely upon the function passed in *infunc*. *real_dump()* called *(*infunc)()* each time it needed the next input character. In a multitasking system, *infunc* could also return input from a co-routine, that is, another process executing concurrently. Once again, *real_dump()* would not need to be changed.

Sorting Anything

In *The C Programming Language*[1], authors Kernighan and Ritchie define a function named *sort()* as a function that has encapsulated the process of sorting so that it can sort any datatype. This includes integers, floats, strings, and any set on which you can define an ordering, such as dates and complex numbers.

The trick is that you, the caller, define the ordering on the datatype and pass a comparison function to *sort()*. Your ordering function will be called with two arguments of the datatype to be sorted. If the first is "larger" (in whatever sense you decide), your function should return 1. If it is smaller, it returns −1; and equal, returns 0.

To sort integers we can define *int_order()* as:

```
int int_order(x,y)
int x, y;
{
if (x>y) return(1);
if (x<y) return(-1);
return(0);
}
```

To sort strings, we can define *string_order()* as:

```
int string_order(x,y)
char *x, *y;
{
return(strcmp(x,y));
}
```

sort() actually requires two function parameters. The second one is used to swap two elements. To be efficient, *sort()* works on an array and moves pointers to the data being sorted rather than data itself. If we were sorting complex numbers, we would need a function to swap them. Here is a function to swap pointers to complex numbers (assume that COMPLEX is an appropriate *typedef*):

```
int complex_swap(x,y)
 COMPLEX **x, **y;
```

---

[1] Brian Kernighan and Dennis M. Ritchie, *The C Programming Language*, (New York: Prentice-Hall, 1978), p. 116.

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```
{
 COMPLEX *temp;

 temp = *x;
 *x = *y;
 *y = temp;
 }
```

To sort an array of pointers to complex entities, we would then call:

```
sort(array,length,
     complex_order,
     complex_sort);
```

Condition Handlers

Another use of function pointers is for signal handlers. Condition handlers are functions called whenever some condition occurs. For example, division by 0 generates an arithmetic signal. Rather than aborting the program, we may transfer control to an error recovery routine, which, at the very least, can print out an error message. While debugging, it can trap back to the debugger.

Following the ANSI X3J11 draft C standard, we set up the signal han-

Listing 1

```
     (* fun)      "a pointer"
     (* fun) ()   "      to a function"
int  (* fun) ()   "               returning an int"
```

Listing 2

```
real_dump(address,infunc,ofp)
...
int (*infunc)();
```

Listing 3

```
#include <signal.h>

void sigfpe();  /* function to handle arithmetic
                   errors */

main()
{
  signal(SIGFPE,sigfpe);
  .
  .
}
```

Listing 4

```
#include <setjmp.h>
#include <signal.h>

void sigfpe();

main()
{
  jmp_buf env;
  .
  .
  if (SIG_ERR == signal(SIGFPE,sigfpe))
      perror("signal")
      exit(-1);
  }

  if (0 == setjmp(env)) {
      printf("inverse = %f\n",matrix_inverse(mat));
  } else {
      printf("no inverse\n");
  }
  .
  .
}
```

Listing 5

```
typedef int FUNC();          FUNC is a function
                             returning an int
typedef FUNC *FUNC_PTR;      FUNC_PTR is a pointer
                             to a FUNC
FUNC_PTR x[];                x is an array of
                             FUNC_PTRs.
```

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dler as shown in Listing 3.

The first argument of *signal()* designates the condition to catch. Some other signals are SIGABRT (abnormal termination), SIGILL (bad or illegal function), SIGINT (interrupt from keyboard), SIGSEGV (memory access violation) and SIGTERM (normal termination). Many systems will also have extra operating system-dependent or machine-dependent signals.

The second argument to *signal()* is the function to execute upon receipt of the signal. It is also possible to pass several predefined values in place of a user-declared function. SIG_IGN means that a given signal should be ignored. SIG_DFL means that the behavior of a signal should be restored to what it was at program startup.

Here is an example of how we might use signals in a real application. First, let us assume that *matrix_inverse()* computes the inverse of a matrix. If the matrix is singular, i.e., has no inverse, a mathematical exception such as division by 0 will take place, which will cause our signal handler to be called (Listing 4). And here is the condition handler.

```
void sigfpe() {
longjmp(1);
}
```

The first call to *signal()* registers the signal handler. If *signal()* does not like its arguments, it returns SIG_ERR, for which we duly check. Otherwise, *signal()* returns a pointer to whatever function was last registered for the condition.

Next, we save our context using *setjmp()*. (See "C Forum," *Micro/Systems Journal*, January 1988, for more on *setjmp()*.) Initially, *setjmp()* returns 0 so that we proceed to call *matrix_inverse()*. If the matrix inverse is computed successfully, we continue after the else clause.

If *matrix_inverse()* raised any sort of arithmetic condition, such as would happen upon singular matrices, a SIGFPE would occur calling *sigfpe()*. *sigfpe()* executes *longjmp()*, which returns to the *setjmp()* and enters the else condition, printing "no inverse."

Final Notes

Earlier I demonstrated how to read function declarations "inside out." I also noted that *cdecl* can help you understand them. A final suggestion is the use of *typedefs*. Here is an example that will help explain:

Suppose we want to declare an array of functions. Or as I said before, we really mean "an array of function pointers," and furthermore, we must know the type that the function returns. In this case, let's say they return *ints*. Now we set up *typedefs*, starting with the functions and working up (Listing 5). Thus, x is clearly an array of function pointers.

By the way, to call the nth function stored in x[ ], we would say

```
result = (*x[n])(args);
```

Conclusion

I have discussed passing functions as parameters and demonstrated several uses. If we had written the examples without function parameters we would have forced the routines to know details immaterial to their operation. They would have to be modified each time we wanted to apply them to a new area.

By separating functions in this manner, we separate concerns. Functions are smaller, applicable to more situations, and become easier to read and debug. Algorithms are data independent—(e.g., *sort()*), I/O independent (e.g., *real_dump*) and algorithm independent (e.g., *signal()*). □

Acknowledgements: I thank Phil Nanzetta and Dave Oskard for proofreading many of these "C Forums."

Don Libes is a computer scientist working in the Washington, D.C., area on artificial intelligence in robot control systems.

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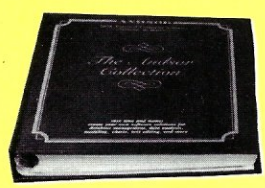

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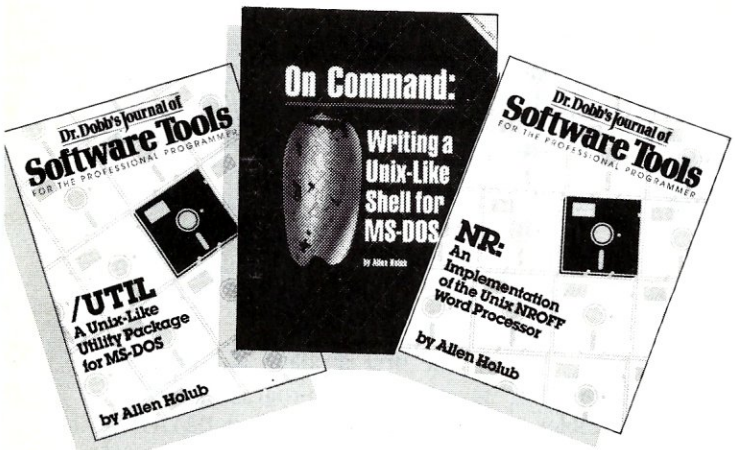

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by Stephen R. Davis

Virtual Memory Techniques: Part 1—Arrays of pointers

This column features tips and techniques for using Turbo Pascal productively on MS-DOS/PC-DOS microcomputer systems, and discusses typical programming problems and their solutions. Reader suggestions, comments, and questions are encouraged, and can be addressed to "Turbo Pascal Corner," Route 5, Box 107K, Greenville, TX 75401, or through MCI mail, 289-6124.

I recently had the opportunity to speak with Brad Silverberg, the vice president of languages for Borland. I asked him what Borland's plans were concerning the further development of its languages. Here is a summary of what he had to say.

Borland's Plans

Borland is keenly aware of the lack of a debugger in the Turbo interface. They have announced a Turbo debugger, which should begin delivery during the first quarter of this year. Unfortunately, it will initially be a standalone product, but it should be integrated into the language environment very shortly. This is essential if Borland is to "keep up with the Microsofts" as this is a major failing in the Turbo environment when compared with the Quick languages.

With respect to Turbo Pascal 4.0, a limitation in the initial release was the lack of emulation support for the IEEE extended range floating point. Without an 8087, the 6-byte Real was the only format available. This effectively made the other real formats useless for commercial development. Borland promises complete emulation for these real formats very soon, perhaps by the time you read this. Apparently, this will be the exact same emulation software as in Turbo C.

At least Borland is considering the development of a Turbo Assembler. They are definitely adding assembly language capabilities to both Turbo C and Turbo Pascal to handle inline assembly code. No new Macintosh language products are planned, although continued support for Mac Pascal is promised.

One final note: Borland considers the Paradox database language to be another member of the language family. Hooks are being added to both Turbo C and Turbo Pascal to allow programs written in these languages to access Paradox. Conceptually, this is like Embedded SQL in languages such as Cobol (an especially accurate comparison since Borland will be adding SQL to Paradox this year). Such access opens a wealth of database power to the Turbo Pascal programmer.

This Month's Topic—Virtual Memory

Accessing large amounts of memory has always been a problem with Turbo Pascal. Turbo Version 3.0 and earlier generations belied their CP/M roots by only allowing the user to directly access 64K of RAM. While Version 4.0 has extended that restriction to the 640K limitation of DOS itself, this is still not nearly enough room for many programmers. This limitation is pretty silly when there is often 20 or more megabytes of hard disk storage space sitting in the same machine (or several megabytes of EMS memory). The problem is how to get at it.

The most straightforward approach is for the user to simply read and write data, as needed, to and from disk. For example, the user might have a few large buffers, named something generic, such as DATA1, DATA2, etc. He could then read data into these buffers as required so that at one point in time DATA1 might contain, say, social security numbers, while at a different time it would contain addresses. Although this plan would probably work, it suffers from a few serious problems.

The first problem is that at any given time the programmer cannot tell just by looking what DATA1 has in it. Giving DATA1 various pseudonyms via an ABSOLUTE declaration does not help. Debugging such a program is also very difficult.

The second problem is a matter of taste. Application routines should only have to worry about application problems—adding the logic to manage data on and off the disk obscures the program, which further complicates the debugging job.

Both of these objections can be addressed using a programming technique known as virtual memory. With virtual memory, the applications program simply declares its data structure to be of any size required, limited only by the amount of available disk space. Rather than access this memory directly, however, the user program must access it through an intermediate known as the virtual memory manager (VMM).

The VMM breaks up the declared data structure into smaller chunks. It is important that these chunks be small enough to fit several into memory at any given time, yet large enough that the VMM will not need to allocate them too frequently. Usu-

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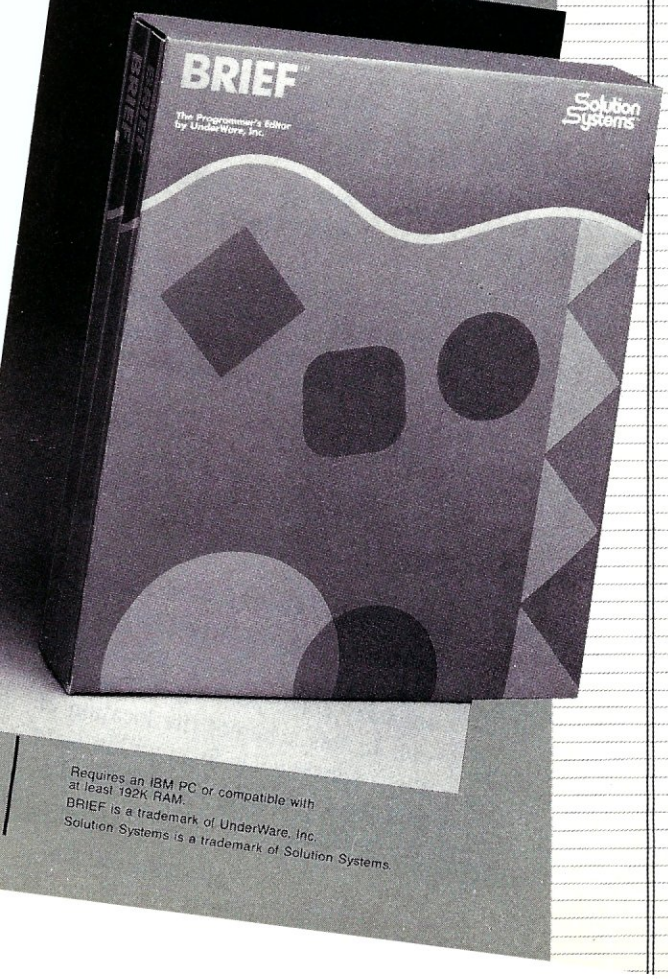

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ally, the nature of the data suggests a logical division. When the user's program asks for a block of data, the VMM checks to see if it isn't already in RAM. If it is, the VMM returns a pointer to where the block is located. If it is not, the VMM first reads the block from the disk. Reading a new block of data into RAM usually means that some older block of data must be removed from RAM to make room. The user program is not directly involved in the actions taken by the VMM to honor its request.

Of course, disks are *much* slower than RAM. Forcing the program to the disk on every access of its data structure could result in extremely slow execution. However, the VMM relies on the fact that, at any given time, a program's interest is usually isolated to a small number of particular areas of the data.

The user program does have to accommodate the VMM in this respect. If it will be necessary to search the data for particular values, then the data must be indexed (or hashed) using an index array that can comfortably fit entirely in RAM. The amount of "hopping around" in the data structure must be kept to a minimum to achieve acceptable performance. This hopping about translates to a large amount of disk thrashing; reading sectors from the disk so that the user program can take a single look at the data before going on to yet another disk request. For example, sorting data in virtual memory using a bubble sort, which makes multiple passes through the data, would lead to unacceptably long execution times.

Listing 1. Sorting matrices of data rapidly using an array of pointers as an index

```
type
     ptr = ^data;
     data = array [0..99] of integer;

var
     pdata : array [1..10] of ptr;
     ddata : array [1..10] of data;
     i,j   : integer;
     temp  : ptr;
     flag  : boolean;

begin
     {print explanation of output}
     writeln ('Data first in physical and then in sorted order');
     write ('Col 1 is the sort column');
     write ('  ---  remaining columns contain the row number');

     {initialize the matrix to predictable values - make col 0
      the sort field}
     for i := 1 to 10 do
     begin
          ddata [i][0] := random (100);
          for j := 1 to 99 do
               ddata [i][j] := i
     end;

     {initialize 'pdata' to point to the idividual arrays}
     for i := 1 to 10 do
         pdata [i] := addr (ddata [i]);

     {now perform a bubble sort on column 0 of 'ddata' - notice
      how we need only exchange the pointer rather than swap the
      entire arrays of 100 integers}
     repeat
          flag := true;
          for i := 1 to 9 do
               if (pdata [i]^[0] > pdata [i+1]^[0]) then
               begin
                    temp        := pdata [i+1];
                    pdata [i+1] := pdata [i];
                    pdata [i]   := temp;
                    flag := false
               end
     until flag;

     {now print out 'ddata' both sorted and unsorted}
     for i := 1 to 10 do
     begin
          writeln;
          for j := 0 to 15 do
             write (ddata [i][j]:4)
     end;
     writeln;
     for i := 1 to 10 do
     begin
          writeln;
          for j := 0 to 15 do
             write (pdata [i]^[j]:4)
     end
```

Computer Memory Addressing

Before we write an example VMM, we should first review how a computer stores data structures in memory. The simplest such structure is the array. In an array, the elements are uniform and numbered, and the location of each element is a function of its number. The individual elements may themselves be composite (non-atomic) structures. Arrays of records and arrays of arrays, also known as matrices, are common. A reference to an element in an array is resolved by multiplying its number by the size of each element and adding this to the address of the base of the array. Take the following example:

```
type      subarray : array
          [1..40] of byte;
var
   data : array [1..80] of
          subarray;
```

In *data*, i.e., an array of an array of bytes, any particular byte is specified by providing two subscripts. A reference *data [i][j]* is resolved as follows:

```
location of data [i][j] =
  location of data + i *
  40 + j
```

In memory, the 40-byte subarray corresponding to *data [1]* appears first, followed by the second 40-byte subarray corresponding to *data [2]*, etc. In this scheme, the location of these subarrays is fixed within *data* and their space allocated is fixed at declaration.

This type of structure is too inflexible for our purposes. With a slight modification, however, we can make this scheme very flexible indeed. Consider the following definition:

```
type
    subarray = array
      [1..40] of byte;

var
    pdata : array [1..80]
      of ^subarray;
```

Here we have defined *pdata* as an array of pointers to arrays. Each *pdata[i]* contains not a subarray, but the address of a subarray. The individual bytes of such a declaration are accessed as *data[i]^[j],* the circumflex indicating indirection.

With such a declaration, there is no implicit ordering of the subarrays in memory. Each *pdata [i]* points to where the subarray is located. In fact, not all of the subarrays need be of the same length, or even present at all. In a technique known as "sparse matrices," those elements of *pdata* that contain no information are assigned the value NIL.

Let's take a look at a simple example application of this concept. It is often necessary to sort a matrix by one of its columns. If we stay strictly with the "array of arrays" approach, the exchanging elements necessary to perform the sort requires that we copy entire subarrays. This can become quite a performance problem if the subarrays become large.

We can avoid this problem by assigning an "array of pointers to arrays" to point to the individual rows of the matrix. We can now sort the matrix by merely exchanging pointers in this indexing array. Listing 1 shows just such a program which bubble-sorts a large matrix by the random data assigned to column 0. At the end of the program, the program prints out the matrix both in "physical" order and in sorted order.

Review the program until you understand the role of *pdata* fully. Notice in particular how *temp* is used to exchange two entire rows of the matrix with three simple assignments. Also notice that the speed of the sort is not a function of the length of the subarrays. Change the "0 . . 99" declaration of *data* into a "0 . . 9999" and notice that there is no difference in execution speed. Rewrite the bubble sort routine to sort *ddata* as a normal matrix and compare performance.

Of course, we can define arrays of pointers to things other than arrays. An array of pointers to records exhibits the same advantages as those outlined above. A record has a further advantage: its constituent members need not be of the same type. This will allow us the flexibility we need to place elements of our VMM in memory as desired, a topic we will continue to develop in our next installment. □

Stephen Randy Davis is one of M/SJ*'s technical editors and a systems programmer. He lives in Greenville, Texas, and is currently completing a Master's degree in Physics.*

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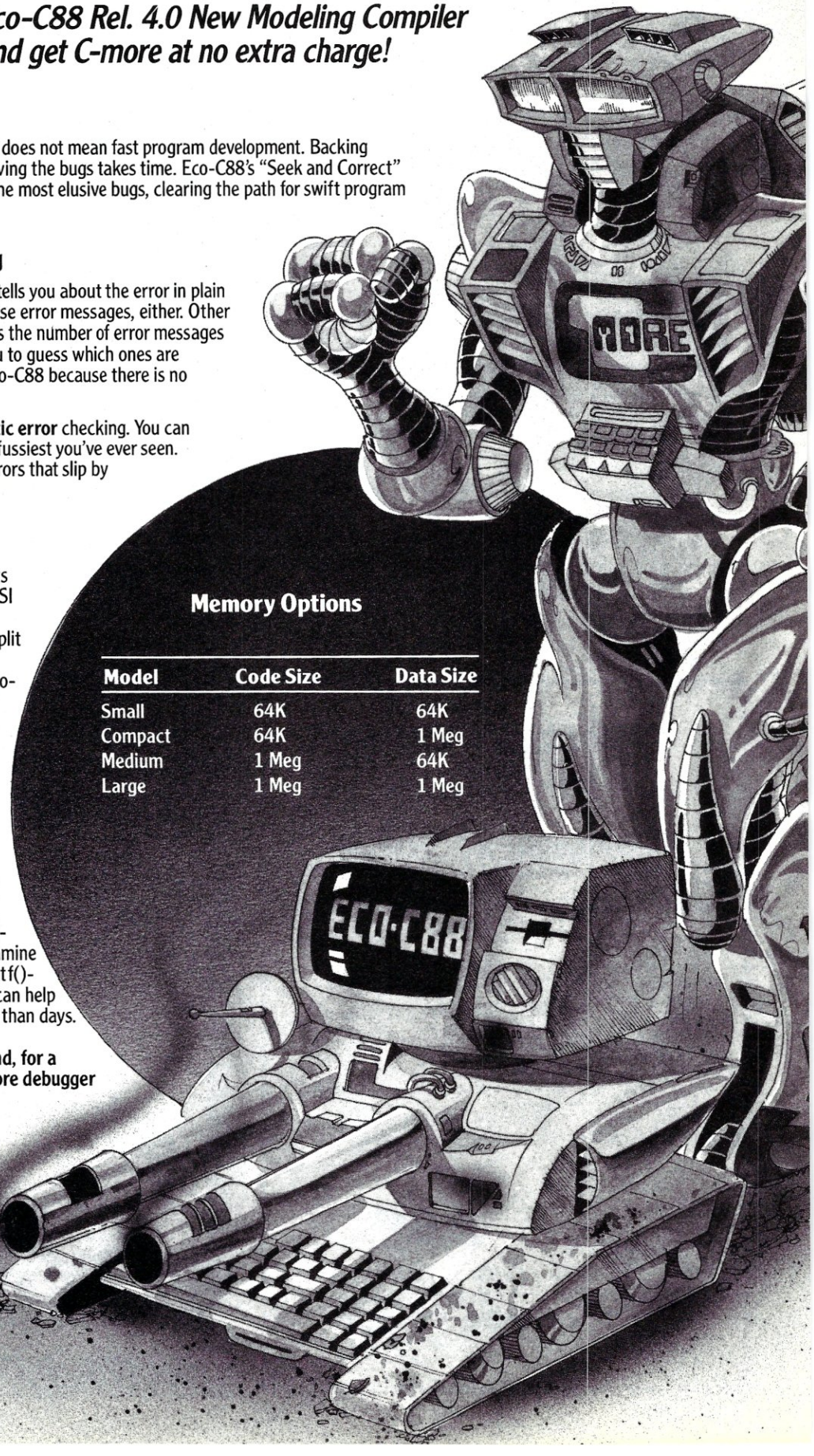

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Technical Brief

Scanning the OS/2 Horizon

by David E. Cortesi

There's a lot of talk about IBM's new Operating System/2. But what is OS/2, and how does it differ from the old familiar DOS? Being a multitasking operating system, OS/2 is capable of loading multiple independent applications and sharing the system hardware in such a fashion that all appear to run concurrently. OS/2 keeps the different applications from interfering with each other. OS/2 can even run one DOS application concurrently with other programs.

OS/2 needs an Intel 80286 or 80386 CPU and at least 2 MB of RAM, i.e., one of IBM's new Personal System/2 machines (model 50 or above), an IBM PC/AT or compatible, or one of the new 386 systems. Be careful choosing non-IBM hardware; OS/2 is a rigorous test of compatibility and won't boot on many "compatibles."

Share and Share Alike

OS/2 uses different methods in sharing each hardware resource: the CPU is time-shared among loaded programs; storage is segmented and allocated using the addressing hardware; and disks are managed as in an MS-DOS system with network-style file sharing. Three fundamental concepts govern resource allocation: the screen group, the process, and the thread.

The *screen group* represents the hardware used by the operator: the display screen, the keyboard, and the mouse. OS/2 supports only one set of hardware, but arranges things so there appear to be 16 virtual displays, each with its virtual mouse and keyboard.

A *process* represents a loaded program plus the resource it owns, such as code and data segments, open files, default drive and directory path, and environment strings.

The *thread* is the executable unit; the entity that is allowed to share the use of the CPU. If a process corresponds to a playing field, then a thread corresponds to the teams that play on it. A thread is actually just a set of registers that occupy and animate the static process.

A screen group will ordinarily be used by just one process, but a process can create other processes and these descendants can share the same screen group. Ordinarily, a process will be animated by only one thread, but one thread can create another so a program can have dozens of concurrent threads in its process (and the system limitation on threads is quite generous).

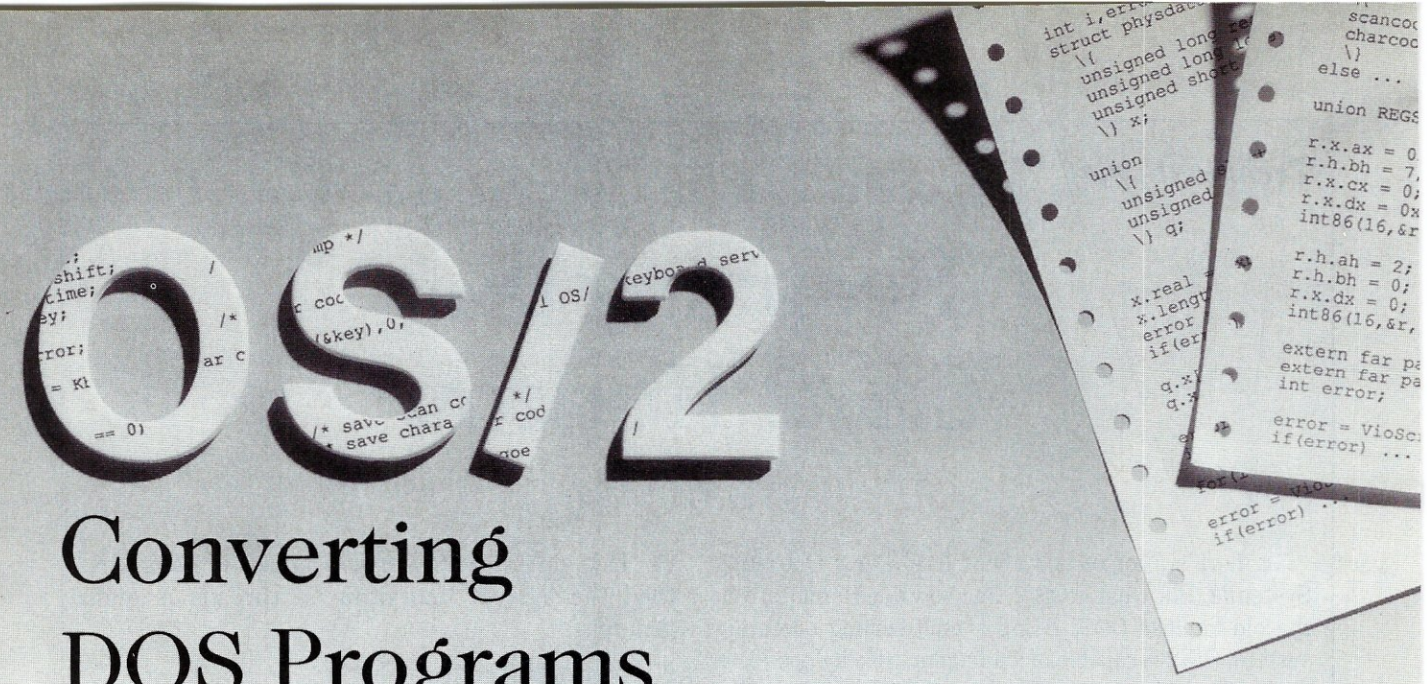
Life in Protected Mode

DOS operates only in the real mode of the 286 CPU. OS/2 takes advantage of what Intel calls the 286's protected mode of operation, and this mode has a lot to do with the character of OS/2 itself. In real mode the programs share one common megabyte of address space. In protected mode there's as much as 16 MB of storage, but all references to it are indirect via the entries in two descriptor tables prepared by the operating system, the Global Descriptor Table (GDT) and the program's own Local Descriptor Table (LDT). The operating system has total control over what the program may touch, modify, or execute. Attempts to access memory outside of that provided by the operating system generate a hardware exception.

Because of the protected mode, OS/2 can treat storage as a pool from which segments are allocated for different programs. The first 640K of storage are given over to a DOS process. The display buffer and ROM segments are set aside under privileged descriptors. Compatible programs can refer to these areas, since they fall into the address space of a real mode program. For DOS, a linked program is a binary image where every part of the program runs together into a sequence of bytes. For protected mode, the identities of segments must be preserved so that the LDT can be built to describe each segment as code or data.

In addition, OS/2 supports dynamic linking, in which some of a program's references to external procedures may be left unresolved until the program is loaded. The object of a dynamic link is an exported name in a dynamic link library. A dynamic link library is an executable file that is prepared like a program by compiling and linking. However, a dynamic link library is not an independent program, but only a package of subroutines that is exported to the programs that refer to them. OS/2 loads dynamic link libraries as required when it loads a client program that needs one. Since a dynamic link package is loaded like a program, it is free to refer to other dynamic

. . . *continued on page 34*



Converting DOS Programs to OS/2 Protected Mode

by David A. Schmitt

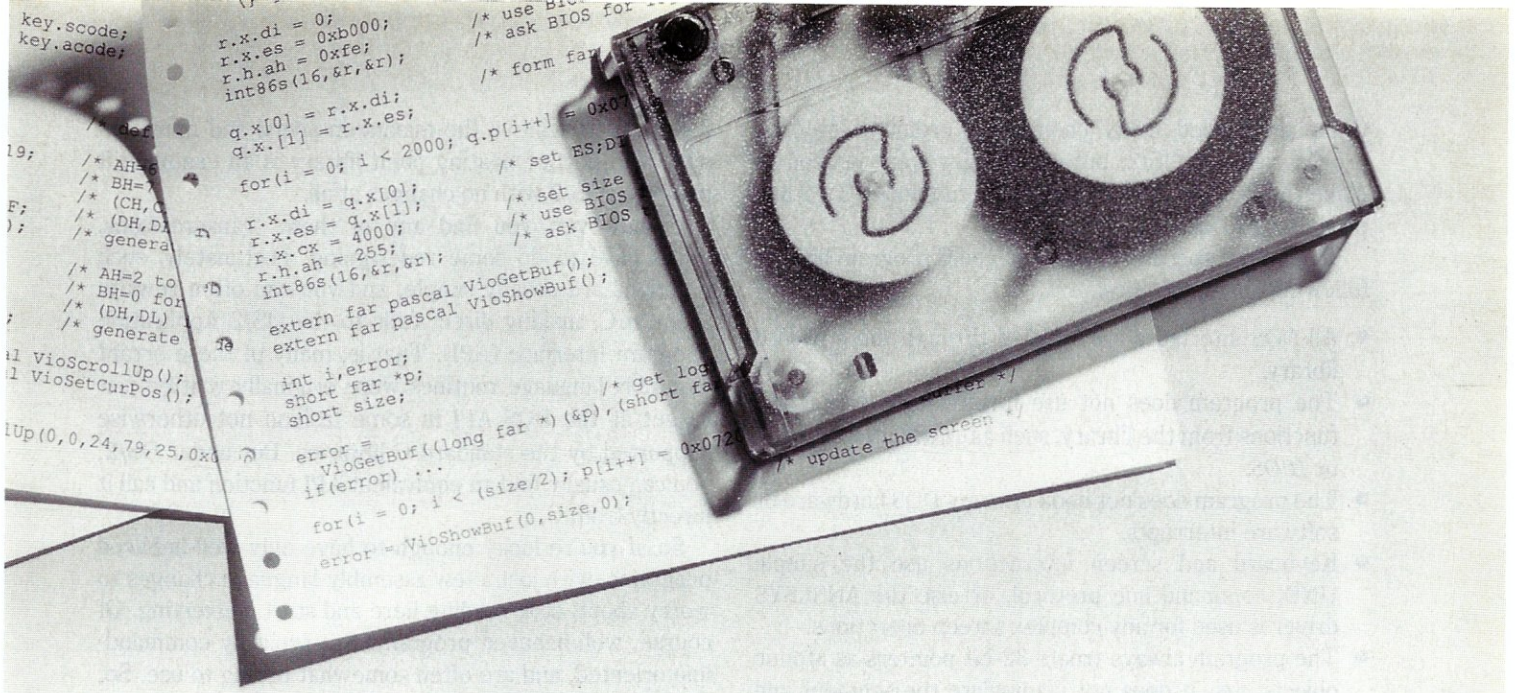
Porting DOS programs to OS/2 is really fairly simple, assuming you follow a few established guidelines.

My company, Lattice, Inc., has been working with pre-release copies of IBM's OS/2 Standard Edition 1.0 since June 1986. During that time, we've converted large amounts of C and assembly language code to run in the OS/2 protected mode, and I'd like to share some of our experiences with you.

Let me begin by saying that our relationship with IBM and OS/2 has been consistently very positive. We agreed to be a test site for OS/2 with some trepidation, since testing a new operating system is usually tedious and frustrating. However, IBM answered all of our questions promptly and accurately, and with each update, OS/2 has become better and better.

By April 1987, when IBM formally announced the availability of this new operating system, it was reliable enough to be routinely used in several of our programmers' workstations, which at that time were IBM PC/AT systems. The major deficiency that prevented us from switching completely to OS/2 was its lack of LAN support, which is a vital part of Lattice's software development environment.

The few remaining problems that we observed after the announcement date were all corrected when OS/2 was officially released in December, and we remain un-



abashed OS/2 boosters. I can't imagine a software developer not getting excited by this major improvement over DOS, and I think we're going to see some significant applications built on top of OS/2.

Let's take a look at the most immediate problem many programmers are now facing: Can I move my DOS software to OS/2 protected mode, and if so, how do I do it? We've already come up with some guidelines that are particularly appropriate for C and assembly language, but can probably be adapted for other languages as well.

Programmer, Know Thy Code!

The first few rules are rather obvious, but I've seen several OS/2 porting efforts derailed because one of these "obvious" steps was overlooked:

- Make sure you have all of the source modules that comprise your application. If you depend on somebody else's code and it's only available in object form, you'll probably be roadblocked. If the object code is a library product that you purchased without source code, you might be able to convince the publisher to give you the source code if you agree to send back the changes that you make for OS/2. On the other hand, if the library is really complex, you might try bribing the publisher so he'll do the work.
- Make sure you know how to build the application. Some of the executables (i.e., .EXE files) have been floating around for some time, and the folks who originally built them may have since disappeared without leaving any tracks.
- Go ahead and actually build the application under DOS to see if it still works. Use the latest version of the C compiler and assembler that you can, since old source code sometimes doesn't make it through the more recent language translators because of improvements in syntax checking.
- If the source code you're using produces a flawed executable, debug it under DOS since you probably work more efficiently in that environment.
- Once you have a clean version running under DOS, save the source and executable. You'll probably need to refer back to this baseline version when you evaluate the performance of the converted program running under OS/2.

Remember that porting to OS/2 is a lot like painting a room: If you do a good job of preparation, the actual work is much easier and the result usually turns out better.

Programs: The Good, The Bad, and The Ugly

The next step is *triage*, or classifying your application according to the likelihood that it will survive the operation. We've identified the following four classes:

1) Well-Behaved Programs

Well-behaved programs use very few operating system services except for the File Manager, which they access through the C library via functions such as *fopen*, *getchar*, *read*, and so on. Since OS/2 has essentially the same file system as DOS, the OS/2 C library can provide exactly the same services, which makes well-behaved programs really easy to convert. In fact, most of the time you can just run the source code through the OS/2 compiler or assembler and then build an executable with the OS/2 linker.

This sounds so simple that you probably wonder if there are any significant programs in this category. Actually there are quite a few. We found that most of our programming tools, e.g., compilers, assemblers, GREP, DIFF, and so on, are well-behaved and moved to OS/2 with few problems. Of course, the Lattice MS-DOS C

Compiler needed many changes in order to produce proper code for OS/2, but no changes were needed to make the original MS-DOS compiler run under OS/2 and produce MS-DOS code.

To be more specific, a well-behaved C program has the following characteristics:

- All DOS interfaces are handled through the standard library.
- The program does not use low-level DOS interface functions from the library, such as *int86, intdos, bdos,* or *BIOS.*
- The program does not hook into any DOS hardware or software interrupts.
- Keyboard and screen interactions use the simple UNIX command line protocol, or else the ANSI.SYS driver is used for any complex screen operations.
- The program always treats 32-bit pointers as atomic objects, i.e., it does not manipulate the segment and offset portions separately.

These same rules apply to assembly language functions called by C programs, although it's usually more difficult to tell if such functions are well-behaved by just "eyeballing" them. So, in addition to the items listed above, you should also look out for these coding practices, which will complicate the conversion:

- INT instructions, which generate software interrupts;
- IN and OUT instructions, which directly access the I/O ports;
- CLI and STI instructions, which change the state of the interrupt enable flag;
- Instruction sequences that change segment register contents, such as

```
MOV   AX,ES ; advance to next paragraph
INC   AX
MOV   ES,AX
```

  which are guaranteed to fail because segment register arithmetic is different in protected mode; and
- Timing loops, such as

```
          MOV    CX,1000   ; wait awhile
DELAY:    LOOP   DELAY
```

  which are risky, even under DOS because they become invalid when you upgrade to a faster computer.

The first three of these five assembly-language coding practices will cause protection violations because OS/2 does not allow normal processes to execute INT, IN, OUT, CLI, and STI instructions. The fourth will usually cause addressing exceptions because the process will attempt to load an invalid selector into a segment register. The fifth just causes the program to behave erratically, since the time delay varies depending on how heavily OS/2 is loaded.

We discovered that much of our assembly-language code had none of these problems and was written at that level just to achieve the maximum speed and minimum size. The Lattice floating point library is an example; it moved to OS/2 with no changes at all.

If, however, you find any of these transgressions, you'll have to do some redesigning. Fortunately, such functions are usually simple, and you can often rewrite them in C, making direct calls to the OS/2 Application Program Interface (API). That is, many of these errant assembly-language routines were originally written just to get at the DOS API in some fashion not otherwise supported by the standard C libraries. But under OS/2, you can usually find an equivalent API function and call it directly from C.

So, if you're lucky enough to have only well-behaved programs, with just a few assembly-language changes to worry about, stop reading here and start converting. Of course, well-behaved programs are typically command-line oriented, and are often somewhat boring to use. So, you'll pay your OS/2 dues later if you decide to spiff these programs up by adapting them to the Presentation Manager—a not-so-trivial task.

2) Highly Interactive Programs

The DOS world is full of programs that do all sorts of magic with the keyboard, screen, and mouse. In fact, one of the things that has made DOS so popular is the ease with which such software can be written. Of course, this has less to do with DOS than it does with the *de facto* hardware standards caused by the IBM PC. The undeniable influence of IBM has simplified many of the aspects of interactive programming that were quite chaotic in the earlier CP/M world, such as memory-mapped video techniques, keyboard scan codes, and extended character sets.

Nonetheless, DOS programs that have a lot of user interaction generally present more OS/2 conversion difficulties than the well-behaved programs discussed above. This is because all interfaces with the BIOS and video RAM must be changed. However, if you've followed the recommended practice of isolating these into a few modules, you'll only be dealing with a small percentage of the computer code.

For example, the Lattice Unicalc Spreadsheet (about 25,000 C source lines) and the Lattice Screen Editor (about 15,000 C source lines) are both highly interactive, screen-oriented programs that write directly to the video buffers. Yet, each required less than one person-week to convert, mainly because the human interfaces were designed in a very modular way. Surprisingly, there was no perceivable loss of performance relative to the DOS versions, as long as OS/2 was not running other tasks.

To convert an interactive program, you must replace all BIOS interrupts with calls to the corresponding OS/2 keyboard (*Kbd*), mouse (*Mou*), and video (*Vio*) functions listed in Figures 1, 2, and 3. These interrupts are usually generated directly by assembly-language functions, or indirectly from C programs via the *int86* function. Then you must modify all routines that directly address the video RAM.

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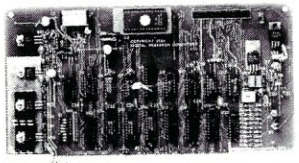

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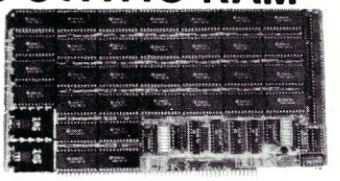

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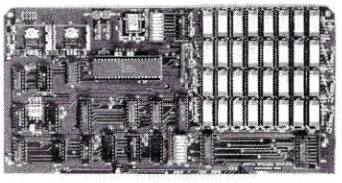

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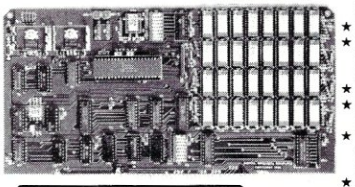

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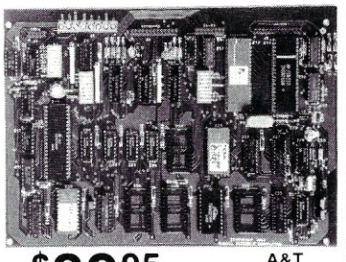

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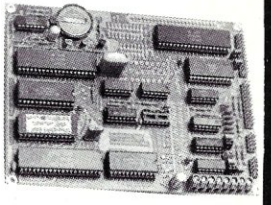

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2.1) Converting The Keyboard Interface

Adapting to the OS/2 keyboard interface is usually fairly straightforward and has no noticeable effect on performance. Listing 1 is a piece of DOS-based C code that obtains a character and scan code via BIOS interrupt 16H, using *int86:*. The same operation in OS/2 can be coded as in Listing 2.

Although the OS/2 version looks more complicated, it actually is not. Most of the OS/2 statements are declarations that would normally be coded once and kept in header files. In fact, the OS/2 Programmer Toolkit includes such header files for both C and assembly language.

The call to *KbdCharIn* probably seems mysterious if you are unfamiliar with the OS/2 Application Program Interface (API). I won't cover the API in detail here, but a few words of explanation should enable you to understand the remaining examples.

First, note that the function is declared with the "far" and "pascal" keywords. The former tells the compiler to use a "far call," while the latter specifies the so-called "pascal calling sequence." This means that arguments are pushed on the stack from left to right and that the function pops the arguments before it returns.

KbdCharIn takes three arguments. The first argument is a 32-bit pointer to the structure in which OS/2 will return information about the next keystroke. The OS/2 API requires that all addresses be passed in full 32-bit form, and so you must make sure that your C

Figure 1. OS/2 Keyboard Functions

FAM	BIOS INT 16H	NAME	DESCRIPTION
F	00H	KbdCharIn	Read character and scan code
–	–	KbdClose	Close logical keyboard
–	–	KbdDeRegister	De-register keyboard subsystem
–	–	KbdFreeFocus	Free keyboard focus
F	–	KbdFlushBuffer	Flush keystroke buffer
–	–	KbdGetFocus	Get keyboard focus
F	01H	KbdGetStatus	Get keyboard status
–	–	KbdGetCP	Get keyboard code page ID
–	–	KbdOpen	Open logical keyboard
R	02H	KbdPeek	Peek at character and scan code
–	–	KbdRegister	Register keyboard subsystem
–	–	KbdSetCP	Set keyboard code page ID
–	–	KbdSetCustXt	Set custom translate table
–	–	KbdSetFgnd	Set foreground keyboard priority
F	–	KbdSetStatus	Set keyboard status
–	–	KbdShellInit	Initialize shell
F	–	KbdStringIn	Read character string
–	–	KbdSynch	Synchronize keyboard access
–	–	KbdXlate	Translate scan code

Figure 2. OS/2 Mouse Functions

INT 33H	NAME	DESCRIPTION
–	MouClose	Close mouse device
–	MouDeRegister	Deregister a mouse subsystem
01H	MouDrawPtr	Draw a pointer
–	MouFlushQue	Flush mouse event queue
–	MouGetDevStatus	Get mouse device status flags
–	MouGetEventMask	Get mouse event mask
–	MouGetHotKey	Get mouse hot key definition
–	MouGetNumButtons	Get number of mouse buttons
–	MouGetNumMickeys	Get number of mickeys per centimeter
–	MouGetNumQueEl	Get number of mouse event queue elements
03H	MouGetPtrPos	Get mouse pointer position
–	MouGetPtrShape	Get mouse pointer shape
–	MouGetScaleFact	Get mouse scaling factors
–	MouInitReal	Initialize real-mode mouse driver
00H	MouOpen	Open mouse device
05H,06H	MouReadEventQue	Read mouse event queue
–	MouRegister	Register a mouse subsystem
02H	MouRemovePtr	Remove mouse pointer from a screen area
–	MouSetDevStatus	Set mouse device status flags
0CH	MouSetEventMask	Set mouse event mask
–	MouSetHotKey	Set mouse hot key definition
04H	MouSetPtrPos	Set mouse pointer position
09H,0AH	MouSetPtrShape	Set mouse pointer shape
–	MouSetScaleFact	Set mouse scaling factors
–	MouShellInit	Initialize shell linkage
–	MouSynch	Synchronize mouse subsystem

Figure 3. OS/2 Video Functions

FAM	BIOS INT 10H	NAME	DESCRIPTION
–	–	VioDeRegister	De-register video subsystem
–	–	VioEndPopUp	De-allocate pop–up display screen
–	–	VioGetANSI	Get ANSI status
F	–	VioGetBuf	Get logical video buffer
–	–	VioGetConfig	Get video configuration
–	–	VioGetCp	Get video code page ID
F	03H	VioGetCurPos	Get cursor position
F	–	VioGetCurType	Get cursor type
–	–	VioGetFont	Get font
F	0FH	VioGetMode	Get display mode
F	–	VioGetPhysBuf	Get physical display buffer
–	–	VioGetState	Get video state
–	–	VioModeUndo	Cancel mode wait
–	–	VioModeWait	Wait for mode change
–	–	VioPopUp	Allocate pop-up display screen
–	–	VioPrtSc	Print screen
–	–	VioPrtScToggle	Print screen key operation trap
F	08H	VioReadCellStr	Read cell string
F	–	VioReadCharStr	Read character string
–	–	VioRegister	Register video subsystem
–	–	VioSavRedrawUndo	Cancel save-redraw wait
–	–	VioSavRedrawWait	Wait for save-redraw
–	–	VioScrLock	Lock the screen
F	07H	VioScrollDn	Scroll down
F	–	VioScrollLf	Scroll left
F	–	VioScrollRt	Scroll right
F	06H	VioScrollUp	Scroll up
–	–	VioScrUnLock	Unlock the screen
–	–	VioSetANSI	Set ANSI mode on or off
–	–	VioSetCp	Set video code page ID
F	02H	VioSetCurPos	Set cursor position
F	01H	VioSetCurType	Set cursor type
–	–	VioSetFont	Set font
F	00H	VioSetMode	Set display mode
–	0BH	VioSetState	Set video state
F	–	VioShowBuf	Display logical buffer
F	09H	VioWrtCellStr	Write cell string
F	0AH	VioWrtCharStr	Write character string
F	–	VioWrtCharStrAttr	Write character string with attribute
F	–	VioWrtNAttr	Write N attributes
F	–	VioWrtNCell	Write N cells
F	–	VioWrtNChar	Write N characters
F	0EH	VioWrtTTY	Write a TTY string

F = Full family-mode support, R = Restricted family-mode support

code expands 16-bit pointers to that 32-bit form. The cast operation

```
(char far *)(&key)
```

does exactly that to the address of the key structure.

The second argument tells *KbdCharIn* what to do if no keystroke is ready. A value of 0 causes the function to wait until the user presses a key.

The third argument is the "logical keyboard handle," which should be 0 for the default keyboard. When OS/2 is managing several applications (called "sessions") at the same time, it gives each one its own keyboard buffer, called "logical keyboard 0," which will receive input characters when that application is in the foreground, i.e., is visible to the user. In some cases an application can request additional logical keyboards, which will have handles greater than 0.

2.2) Converting The Mouse Interface

If you access the mouse under DOS via software interrupt 33H, the OS/2 conversion is very similar to the keyboard work described above. Figure 3 shows which *Mou* calls in OS/2 correspond to the interrupt 33H operations.

However, if you rely upon a special mouse interface provided by a DOS driver or pseudo-driver, you're in for some redesign. Most DOS mice on the market today include the necessary software to handle the interrupt 33H protocols, and I'd suggest that you change your DOS code to use that approach. Then it should be a straightforward job to convert that code to OS/2 using the *Mou* functions.

2.3) Converting Video BIOS Calls

If your DOS program accesses the video subsystem through BIOS interrupts, then the conversion to OS/2 is, once again, very similar to the keyboard work described above. For example, Listing 3 is a DOS code snippet that clears the screen and moves the cursor to the upper left corner. The same operation in OS/2 can be accomplished by the sequence shown in Listing 4.

VioScrollUp accepts seven arguments. The first four define the scrolling area, that is, the upper left and lower right corners of the block being scrolled. Here we're dealing with the entire screen of 25 rows and 80 columns, and so the upper left and lower right corners are (0,0) and (24,79), respectively. The fifth argument specifies the number of lines to scroll, 25 in this case. The sixth argument is the attribute and character used to fill the new lines on the screen. The attribute value here is 7 for white-on-black, and the character value is 0x20, which is a blank.

The final argument to *VioScrollUp* and most other *Vio* calls is the "logical screen handle." As with the keyboard, the OS/2 session manager provides a separate video buffer for each active session. The handle for this default buffer is 0. The application program can create additional video buffers if necessary, and these will have handles greater than 0.

VioSetCurPos is much simpler. It positions the cursor to the row and column specified by the first two arguments. The third argument is the logical screen handle.

2.4) Converting Video RAM Accesses

If your program paints the screen by writing directly into the video RAM, you must deal with the fact that OS/2 severely restricts your access to this special area of memory. When you run in protected mode, the video RAM doesn't even appear in your memory map, and so if you try something like writing into the monochrome video buffer at *segment:offset* B000:0000, OS/2 will abort your process with an addressing exception.

Listing 5 is an example of some non-portable DOS C code for clearing the monochrome screen. The strange-looking "union" is used to form a valid *segment:offset* pointer to the video buffer. Then the loop simply resets that area to blanks with white-on-black attributes.

Now, if you try to run this code in OS/2 protected mode, you'll see a prime example of an OS/2 abort message. But text-mode programs like this one can be easily converted to OS/2; you just write into the logical video buffer and let OS/2 update the physical buffer. This technique is really nothing new; it's exactly what you have to do in DOS-based multitasking systems such as IBM Topview and Microsoft Windows. For example, the code in Listing 6 offers a Topview-compatible example. Here we use video BIOS function 254, which leaves ES:DI intact if Topview or some other session management system is not installed. Otherwise, ES:DI is loaded with the *segment:offset* pointer to the logical video buffer. Then, after the buffer is cleared, we use video BIOS function

Listing 1. DOS based C code that obtains a character and scan code via BIOS interrupt 16H.

```
union REGS r;           /* define register set */

r.h.ah = 0:             /* use code 0 in AH to get next
                           character */
int86(0x16,&r,&r);      /* generate INT 16H */
scancode = r.h.ah;      /* save scan code from AH */
charcode = r.h.al;      /* save character code from AL */
```

Listing 2. OS/2 based C code that obtains a character and scan code via BIOS interrupt 16H.

```
extern far pascal KbdCharIn();

struct CHARDATA         /* structure to hold data from
                           KbdCharIn */

  char acode;           /* ASCII character code */
  char scode;           /* scan code */
  char status;          /* device status */
  char nls;             /* shift state for National
                           Language Support */
  short shift;          /* keyboard shift state */
  long time;            /* timestamp */
  key;

int error;              /* error code */

error = KbdCharIn((far char *)(&key),0,0);  /* call
                           OS/2 keyboard service */

if(error == 0)

  scancode = key.scode;      /* save scan code */
  charcode = key.acode;      /* save character code */

else ...                    /* error handler goes here*/
```

Listing 3. DOS code to clear the screen and return the cursor to the upper left corner.

```
union REGS r;         /* define register set */

r.x.ax = 0x0619;      /* AH=6 for scroll up, AL=25 for
                         entire screen */
r.h.bh = 7;           /* BH=7 for white-on-black
                         attribute */
r.x.cx = 0;           /* (CH,CL) is upper left
                         (row,col)*/
r.x.dx = 0x184F;      /* (DH,DL) is lower right
                         (row,col)*/
int86(16,&r,&r);      /* generate video interrupt */

r.h.ah = 2;           /* AH=2 to set cursor position */
r.h.bh = 0;           /* BH=0 for page 0 */
r.x.dx = 0;           /* (DH,DL) is (row,col) */
int86(16,&r,&r);      /* generate video interrupt */
```

Listing 4. OS/2 code to clear the screen and return the cursor to the upper left corner.

```
extern far pascal VioScrollUp();
extern far pascal VioSetCurPos();
int error;

error = VioScrollUp(0,0,24,79,25,0x0720,0);
if(error) ...

error = VioSetCurPos(0,0,0);
if(error) ...
```

Listing 5. Non-portable DOS C code for clearing the monochrome screen.

```
int i;
union

  unsigned short x[2];
  unsigned short far *p;
  q;

q.x[0] = 0;          /* form segment:offset pointer to
                        video RAM */
q.x.[1] = 0xb000;

for(i = 0; i < 2000; q.p[i++] = 0x0720);
```

Listing 6. Topview code to clear the screen.

```
int i;
union REGSS r;          /* define register set with
                           segments */
union                   /* used to make video RAM pointer */

  unsigned short x[2];
  unsigned short far *p;
  q;

r.x.di = 0;             /* set ES:DI to video buffer */
r.x.es = 0xb000;
r.h.ah = 0xfe;          /* use BIOS function 254 */
int86s(16,&r,&r);       /* ask BIOS for logical buffer
                           pointer */

q.x[0] = r.x.di;        /* form far pointer to logical
                           buffer */
q.x.[1] = r.x.es;

for(i = 0; i < 2000; q.p[i++] = 0x0720);  /* clear the
                                             buffer */

r.x.di = q.x[0];        /* set ES;DI to start of logical
                           buffer */
r.x.es = q.x[1];
r.x.cx = 4000;          /* set size to 25 rows, 80
                           columns */
r.h.ah = 255;           /* use BIOS function 255 */
int86s(16,&r,&r);       /* ask BIOS to update screen */
```

Listing 7. Topview code to clear the screen adapted for OS/2.

```
extern far pascal VioGetBuf();
extern far pascal VioShowBuf();

int i,error;
short far *p;
short size;

error =                       /* get logical video
                                 buffer ptr */
  VioGetBuf((long far *)(&p),(short far *)(&size),0);
if(error) ...

for(i = 0; i < (size/2); p[i++] = 0x0720); /* clear the
                                              buffer */

error = VioShowBuf(0,size,0);             /* update the
                                             screen */
if(error) ...
```

Listing 8. A program to directly access the physical video buffer.

```
extern far pascal VioGetPhysBuf();
extern far pascal VioScrLock();
extern far pascal VioScrUnlock();

int i,error;
struct physdata
```

... continued on next page

255 to update the screen. If no session manager is active, function 255 does nothing, since we've actually been writing to the physical buffer.

The equivalent OS/2 code (Listing 7) looks quite similar, except that the BIOS interrupts are replaced with *Vio* calls. *VioGetBuf* returns a pointer to the logical video buffer. The pointer is stored into the 32-bit area whose 32-bit address is given by the first argument. That's the reason for the *(long far *)* cast in that argument position. The second argument is a 32-bit pointer to a short integer where the buffer length (in bytes) will be returned, and again, a cast operation is needed. The logical video handle completes the argument list, as we've already discussed.

After clearing the logical buffer, you must use *VioShowBuf* to get the physical screen updated, which will actually occur only if your program is running as the foreground session. The first argument is the offset into the logical buffer, and the second is the number of bytes being updated.

So, if you were prudent enough to incorporate this type of Topview logic into your screen-oriented programs, you'll have an easy time moving them to OS/2. However, if you scattered absolute addresses of video buffers throughout your code, you'll have to do some clean up first. I'm ashamed to admit that we had a few programs like that, and we found it worthwhile to first clean them up under DOS using the techniques already described. After that, the move to OS/2 was painless, and we improved our DOS versions as well.

2.5) Converting Graphic Programs

So far, we've only discussed text-oriented programs, that is, those programs that use the non-graphical video display modes. While OS/2 Standard Edition 1.0 provides excellent support for such applications, it has little to offer if your programs generate graphical displays.

However, the situation is not completely hopeless. Contrary to what some would have you believe, you do not have to wait for the Presentation Manager before you can move graphical programs to OS/2. The new operating system does provide the means to gain direct access to the physical video buffer and the display adaptor's I/O ports, both of which are necessary for generating graphical displays. This is not too surprising, since the Presentation Manager is itself an application on top of the OS/2 base, and it needs these capabilities.

A detailed discussion of low-level graphics programming under OS/2 would be too lengthy for this article, but Listing 8 offers a small example of how you can directly access the physical video buffer. *VioGetPhysBuf* maps the specified video buffer into your address space, if possible, and returns one or more selectors that you can use to form 32-bit pointers for protected-mode access. One selector is returned for each 64 kilobytes of video buffer area. The mapping, however, is only valid when your program is executing in the foreground, that is, when it has control of the actual display screen. So, you must call *VioScrLock* before accessing the buffer and

```
... continued
q.x[0] = 0;                          /* form far pointer to
                                        buffer */
q.x[1] = x.prots[0];

error = VioScrLock(1,(char far *)(&i),0);
                                     /* lock the screen */
if(error) ...

for(i = 0; i < 2000; q.p[i++] = 0x0720);
                                     /* clear the buffer */

error = VioScrUnlock(0);
                                     /* unlock the screen */
if(error) ...
  unsigned long real;                /* physical video
                                        buffer address */
  unsigned long length;              /* buffer length */
  unsigned short prots[2];           /* protected-mode
                                        buffer selectors */
  x;

union                                /* used to make video
                                        RAM pointer */

  unsigned short x[2];
  unsigned short far *p;
  q;


x.real = 0xb0000;                    /* load physical
                                        address of buffer */
x.length = 4000;                     /* load buffer length*/
error = VioGetPhysBuf((struct physdata far *)(&x),0);
                                    /* Map buffer */
if(error) ...
```

VioScrUnlock when you are finished. The former, as used in this example, does not return until the user brings the program to the foreground via the session manager. Then it locks the screen so that the user cannot switch to another session until the current program unlocks the screen via *VioScrUnlock*.

Now, even though the example in Listing 8 writes to the physical video buffer in text mode, you can use this same technique to draw graphic images. I won't present an example here because there are so many subtle points that this topic deserves an article of its own, however, the general approach is:

- Use *VioGetConfig* to determine the type of display adaptor equipped. *VioGetMode* and *VioGetState* might also be needed to determine the current display mode and state.
- Use *VioSetMode* and, if necessary, *VioSetState* to establish the appropriate graphical mode.
- Create separate execution threads using *VioModeWait* and *VioSavRedrawWait* to re-establish the display mode and save or restore the display data when a session switch occurs.
- Use *VioGetPhysBuf*, *VioScrLock*, and *VioScrUnlock* as above to gain access to the physical video buffer in order to draw the graphic images.

If you need to access the display adaptor's I/O registers, as is often the case with EGA displays, then you'll also have to create a function with I/O privileges that you can then call from your program. This is necessary because normal OS/2 processes are not allowed to execute I/O instructions.

As I said, graphic programming can be done in OS/2 without relying upon the Presentation Manager. It isn't as easy as displaying text alone, but if you study the OS/2 Technical Reference thoroughly and try a few simple experiments, you'll quickly get the hang of it.

3) Terminate-Stay-Resident (TSR) Programs

TSR programs are a special category of highly interactive DOS applications. The typical TSR, such as Borland SideKick or Lotus Metro, is dormant until the user activates it using a hot key. Then it opens a window on the screen and enters into a dialogue with the user to accomplish some task, such as updating an appointment calendar. When this dialogue is finished, the TSR restores the original screen contents and goes back to sleep. So, TSR programs typically have the same OS/2 conversion problems as the interactive programs discussed earlier; that is, their keyboard, mouse, and screen access techniques must be changed to meet the OS/2 requirements.

In addition, you need to decide if you want the TSR to become a normal OS/2 process or a "monitor" process. If the TSR is providing a data management service, such as an appointment calendar, you could simply load it as an

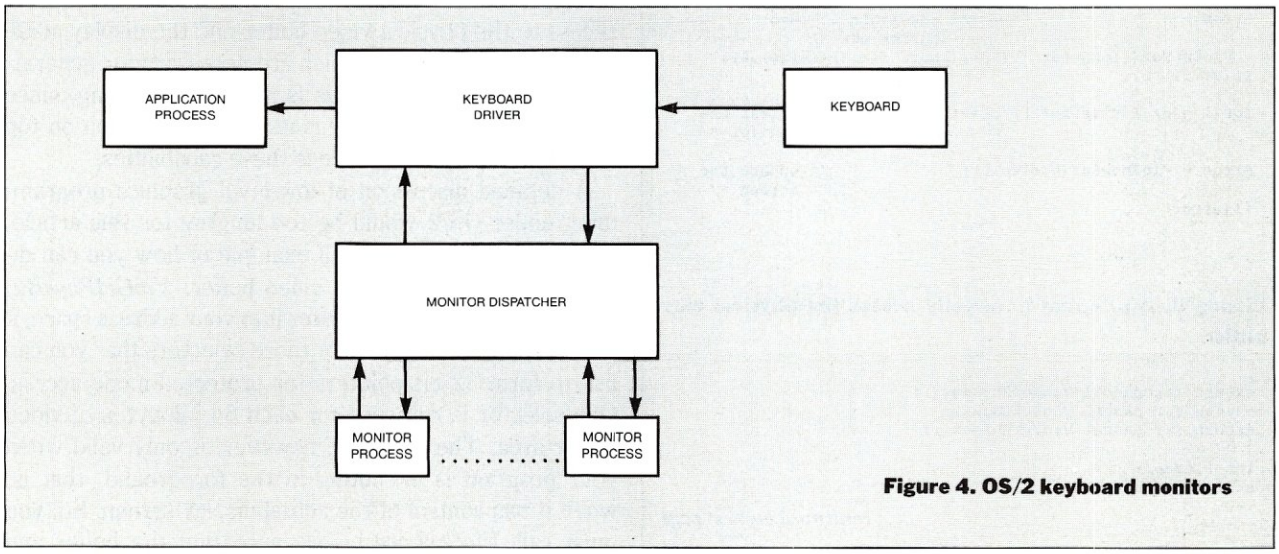

Figure 4. OS/2 keyboard monitors

OS/2 session and use the session manager hot keys to activate the calendar.

However, if the TSR has to continuously monitor the keyboard input, as a keyboard macro package such as Prokey must do, then you need to hook it into the keyboard I/O driver as a monitor process. Fortunately, OS/2 provides an elegant way to do this which eliminates the TSR contention problems that often occur under DOS. Figure 4 shows how this works.

The monitor process calls *DosMonOpen* and *DosMonReg* to open a monitor chain in the device driver and register itself as a monitor. Then each time the device driver receives a keystroke, it sends a "keystroke data packet" out to the first monitor in the chain. That monitor reads the packet via *DosMonRead* and chooses to absorb the keystroke, pass it on, or substitute one or more pseudo-keystrokes. These latter two operations are done via *DosMonWrite*, which sends the keystroke packet on to the next monitor in the chain. Unless everything gets absorbed in the chain, the original or substitute keystrokes eventually reach the end of the chain and are returned to the device driver, which passes them on to the application program that is waiting for keyboard data.

As with graphical techniques discussed above, there are many subtleties you must keep in mind when designing a monitor process, and so I won't attempt a thorough description here. The main thing to keep in mind, though, is that a monitor must be very fast or else the system will appear to be sluggish. Also, note that you can hook monitors into some of the other standard character drivers. For example, the OS/2 print spooler is implemented as a monitor process hooked into the printer driver.

4) I/O Drivers

I/O drivers present the toughest conversion challenges, if only because they hook into the messy guts of DOS and typically require a large amount of assembly language programming. Furthermore, as with DOS TSR programs, the rules for creating drivers have not been well documented, and so designers have had to use *ad hoc* techniques learned by experimentation.

Unfortunately, OS/2 drivers tend to be much more complicated than their DOS counterparts because they must operate in a multitasking environment supporting both real-mode and protected-mode processes. Because of these significant environmental differences, the typical DOS driver doesn't survive the conversion, except for small sequences of code that deal directly with the device. In other words, if you write drivers for a living, roll up your sleeves because you've got a lot of programming work ahead of you.

We were initially concerned that the techniques for creating OS/2 drivers would remain mysterious and that we could not obtain the knowledge experimentally because OS/2 is so well-protected. However, IBM's documentation was a pleasant surprise, because it explains this arcane topic in great detail and includes a fairly complete example. Microsoft has also been providing a driver

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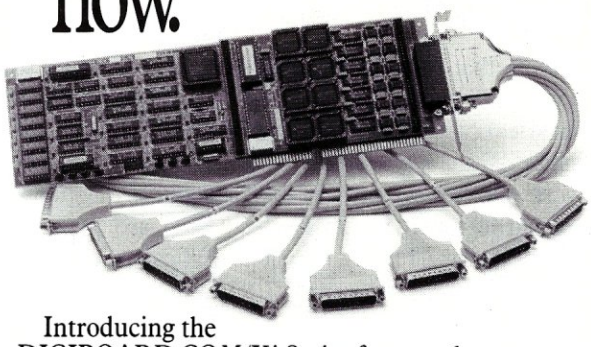

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development kit, including an OS/2 kernel debugger, to attendees of its driver design course.

Family Mode Considerations

The final topic you must consider when converting a DOS program to OS/2 is whether you want the result to be a "family-mode application." This means that the program will be put together in such a way that its executable, i.e., the .EXE file, will run correctly in OS/2 protected mode, OS/2 real mode, or under DOS 3.x. The OS/2 Programmer Toolkit includes the BIND utility program and a special library, API.LIB, to construct family-mode applications.

There are three simple rules for achieving family compatibility:

- Don't use any OS/2 API calls that are not part of the family-mode repertoire unless your program first tests that it is running in protected mode.
- Don't do any DOS-specific things, such as generate software interrupts, unless you verify that the program is running in real mode.
- Don't do any internal manipulation of 32-bit pointers unless you first check whether your program is in real or protected mode and choose the appropriate algorithm.

Note that the first rule requires that you know which functions in the C compiler library (and possibly other libraries) call API functions that are not allowed in family mode. When we converted the Lattice C Compiler, we were able to make most of the mainstream functions fully compatible with family mode. These are kept in the LC.LIB library. Lattice functions that can be used only in protected mode are kept in LCP.LIB, while those that can be used only in real mode are in LCR.LIB.

Figures 1, 2, and 3 indicate which of the keyboard, mouse, and video API functions are available in family mode. In the FAM column, an F means that the function is fully supported in the family mode, while an R indicates that there are some restrictions on family-mode use of the function. The OS/2 Technical Reference provides this information for all of the API functions.

Summary

Our experiences at Lattice in converting DOS applications to OS/2 protected mode have been much happier than we originally expected. While this exciting new operating system was designed with an eye to the future, it remains very compatible with the past. Good luck in your move to OS/2! □

David A. Schmitt spent 18 years at Bell Laboratories, where he was involved in the design of many real-time control systems, including a fault-tolerant version of UNIX. Since 1983 he has been President of Lattice, Incorporated, which developed the popular Lattice C Compiler and is now a subsidiary of SAS Institute.

Continued from page 23

link packages. Only one copy of any executable file, program, or library is loaded, no matter how many processes may be using it concurrently.

How a Process Finds the Handles

When a program is loaded, it is converted into a process with an address space that includes its loaded segments. The process is animated with a single thread that begins execution at the defined program entry point. The process finds out about the system using system calls that return information or give access to read-only data segments. One such, the environment segment, contains two blocks of strings: one that defines variables in the usual "name=value" form, and one that contains the program's executable file name and its command-line parameters.

The process receives three open file handles for standard input, standard output, and error reports (the standard printer file of MS-DOS is not supported by OS/2). These handles are prepared by the process's parent and will usually be associated with the screen group's keyboard and screen. If the parent is the command shell, the standard handles may have been opened to disk files or to pipes, buffered communication paths shared with other processes.

A process can set up its own handlers for the exception events in three classes. The first class is software signals generated by other processes, a class that includes the Control-C signal. The second class of events covers certain hardware traps. The third class is the Exit list, a list of procedures that will be called when a process terminates, regardless of the cause of termination. There are system calls to add a routine to the exit list, and to remove it, so a linked subsystem could install an exit handler while working for a process, and remove it when the process is finished.

An OS/2 system is host to a number of independent processes, each representing a unique address space. The processes, in turn, are home to a flock of threads that execute concurrently and asynchronously. A wealth of methods are available by which the processes may share and exchange data, and by which the threads may coordinate their activities.

OS/2 has been designed from the ground up to make it easy to add new subsystems. A new functional subsystem can be added in the form of a new dynamic linking library, and it becomes immediately accessible to every other part of the system. Such power and flexibility present a new programming challenge to systems integrators. But with perseverance and a little guidance, it will become as easy to find your way in OS/2 as it is to traverse the DOS landscape. □

This overview was condensed from The Programmer's Essential OS/2 Handbook *by David Cortesi, which is scheduled for publication this spring by M&T Books.*

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Spooling on Novell Networks with Pascal

by Ed Rought and Tom Hoops

There are a number of advantages to providing network control over printers through spooler functions, such as those described in this article.

Providing solutions to multiple-user computer applications is often rewarding but difficult to accomplish. With users requiring true multiuser file access, multiple printers, internetwork message handling, and easy network management the new wave of personal computer-based networks provides real-world challenges to system integrators. As commercial application developers we have learned, often the hard way, that the solutions to these requirements fall to the people integrating the network and the users. To aid other system integrators in solving network applications, we will provide a case study of some of the problems we have encountered and solutions we have reached in print spooler control on Novell networks.

The System Requirements

In late 1986, after installing our office network using Novell Advanced Netware 2.0a, we were immediately faced with two projects that required multiple printer control. The first requirement was for our own office. We needed to provide printing capabilities for information requests received from our national product advertising. This task required that we print shipping labels at the workstation where the information request was entered, and that sales tracking records were printed immediately

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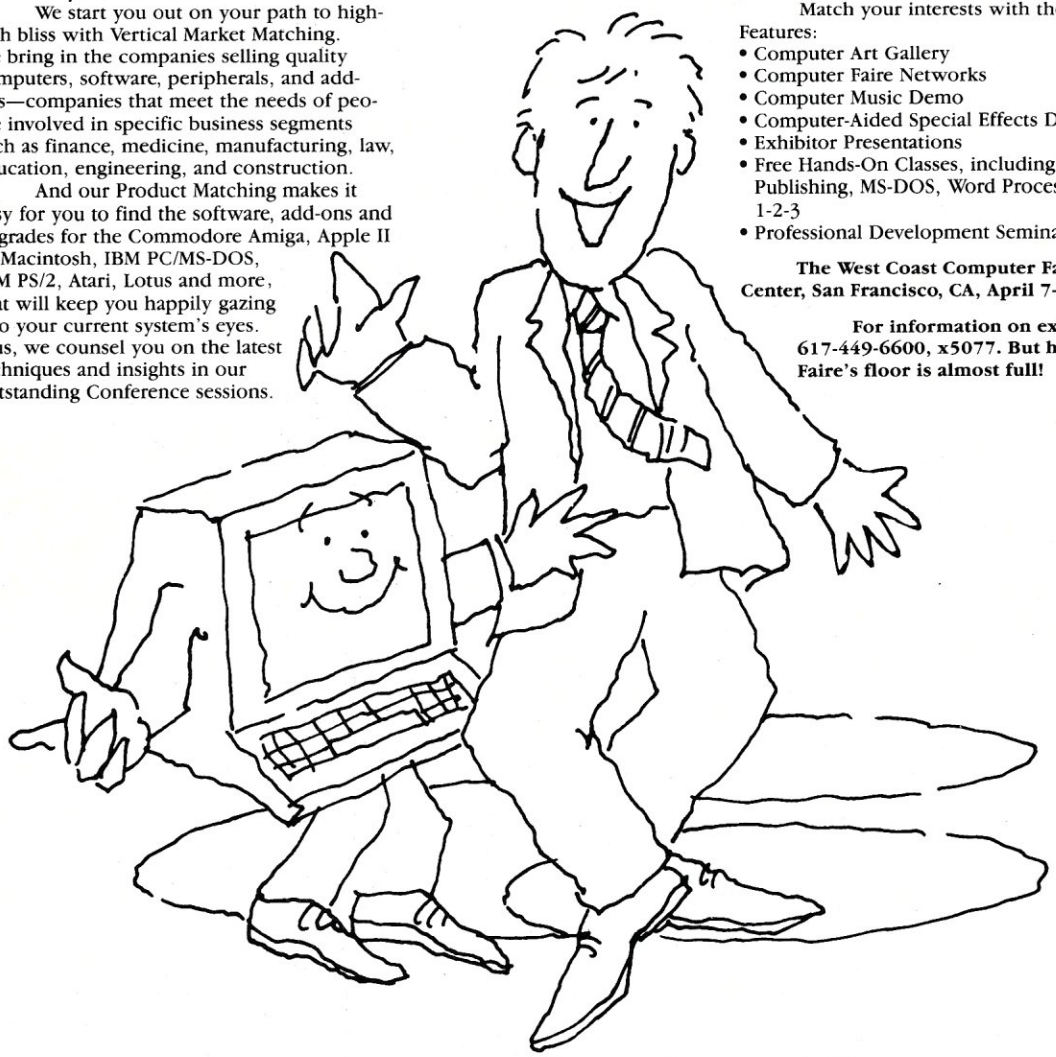

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after the labels. The second project involved creating an application for a local client that provided control of five printers by seven users on a network. The client would be using the workstations as point-of-sale terminals and the staff needed to print different forms based on the requirements of the customer being served at each station. Although the complexity of the two situations were different, the control solutions were very similar.

The Solution Options

Each case could be solved by a number of options. However, most of the potential solutions, other than network control, had major drawbacks. In our in-house prospect tracking system, we boiled the options down to three possible choices.

The first entailed providing multiple printers to each workstation with a manual- or software-controlled printer switch to control printer selection. This solution lowered software development costs by not requiring development of routines to interact with Netware. However, the hardware costs would be higher, since the network printers could not be utilized and a switch would be needed to control the printer selection. This option also raised the probability for operator error in selecting the proper printer for each form.

The second option for our tracking system was to provide one printer and have the operator manually change the paper before printing the material. This had the lowest cost because no additional hardware was required, and the software would be simple. However, the labor cost and lost time required to change paper far outweighed the savings on equipment and software.

The last and most practical solution was to use the Novell function calls to start and stop the spooler from within the application. This allows the local printing of labels when the spooler is disabled and the remote printing of sales tracking forms when the spooler is enabled. Otherwise, the Novell spooler will capture all printed outputs from the applications. The only disadvantage to using the spooler is the time required to create the new routines and test their functionality. The flexibility to split the task over the existing equipment, along with the potential for later adding additional printers to the file server to perform the task from any workstation, led us to select this option.

In our second project, the client with a point-of-sale problem required a similar kind of solution. The first possible option was to use a software-controlled printer switch to change printers when a command was received in the text stream. This option would lower software development costs, be transportable to a single user environment, and not be dependent on changes that might occur in network software. On the down side, the functionality would depend on another manufacturer, the hardware cost would be higher, control over the flow of print jobs would be poorer, there would be potential incompatibilities between switch manufacturers, and there would be a need for additional hardware. Of these negative side effects, relying on an additional manufacturer was our largest concern. In a market as volatile as the computer industry, we felt that entrusting our customer's functionality to a small group of printer switch manufacturers was not a reliable solution.

The next option we considered for our customer was to provide each workstation with its own set of printers. From the outset, this option was almost unthinkable, but we included it because it offered a viable solution if the software writers could not create the needed routines. Eventually, we discarded this solution because of the high cost and space requirements needed to provide three to five printers to each workstation.

We created routines to set spooler flags, obtain printer status, and modify and close the spooler device so we could have total control over the spooler functions.

The final option was to provide network control of each printer through the available network spooler functions. The advantages to using this approach include: transparent printer control, lower investment in hardware, more space for buffering of output documents, control by the system, and status checking for each print job.

Although this option sounds wonderful, there are disadvantages. First, extensive software development and an in-depth testing process are required. Secondly, there is the potential to create a backlog of print jobs as more workstations access the network printers. Third, the potential exists for a document, or portion of a document, to be lost if the Netware was not installed with sufficient communications buffers. The default for communication buffers was 40 packets or segments of transmitted information. We found that if seven users sent their documents at the same time, one to three of those documents would be lost. By increasing the buffers to 100 packets we were able to send all these documents safely. Since the buffers are allocated in the server's RAM, additional RAM may be required if the server is close to filling its present available RAM.

One Solution

We also opted for the network control approach because of the high cost of the other options. Our customer assisted us by determining the maximum number of users that would be accessing the five network printers at one time. We felt that installing a faster printer would elimi-

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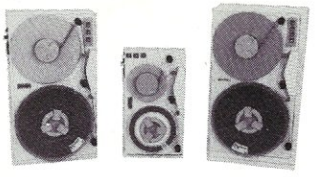

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nate any unreasonable delays in the potential printer backlog.

These two decisions left us with the task of creating our own routines to handle printer control through the network. We had obtained the Netware function calls from Novell, along with their routines for using the function calls. When we began examining the material received from Novell, we discovered that the routines were in assembly language and the Pascal portions used external calls to the assembly language routines. What made this disheartening was that there was virtually no documentation on how to use the code provided, and the person who wrote the Pascal routines was no longer available. The last straw was that the assembly language routines were not compiled to object code, and to compile them required an assembler two or three versions beyond the one we had. Thus, we decided to write our own routines so we could have total control of the spooler control routines.

We decided to initially create routines to: set the spooler flags, obtain the printer status, modify the current spooler device, and close a spooler device. With these four routines we could output data to any printer on the network or to local printers at any point in an application. The following sections provide a discussion of each of these routines.

Listing 1. Set_Spool_Flags4

```
procedure Set_Spool_Flags4(PrntNo : byte);
{
This is a netware 4.0 function call and will set the
network printer spooler spool flags.

 Process for outputing:
   start with LST device closed (local)

   Modify_LST_Device
   Set_Spool_Flags(N)
     Perform output
   Close_LST_Device
   repeat for new output
}

type
  {Request Buffer Type}
  ReqBuffType = record
    PacketLength : integer;       {Integer length of the
                                   request buffer}
    SetFlags     : byte;          {$02 Set Spool Flags}
    PrntFlags    : byte;          {Print Control Flags
                                   $08 = Suppress auto
                                         form feed at
                                         end of print job
                                   $20 = Delete spool
                                         file after
                                         printing
                                   $40 = enable tab
                                         expansion
                                   $80 = Print banner
                                         page}
    TabSize      : byte;          {Tab size, 1 - 20}
    TargetPrinter: byte;          {Output printer
                                   number, 1 - n}
    NumCopies    : byte;          {Number of copies,
                                   0 - 255
                                   0 = no printing}
    FormType     : byte;          {Form Type, 0 - 255}
    BannerTxt    : array[1..13] of char; {Banner
                                  Heading, not used here}
    Terminator   : byte;          {Null terminator for
                                   buffer, $00}
  end;

  {8086 register type}
  RegType = record
    case integer of
      1 : (AX, BX, CX, DX, BP, SI, DI, DS, ES, Flags :
integer);
      2 : (AL, AH, BL, BH, CL, CH, DL, DH            :
byte);
  end;

var
  ReqBuff : ReqBuffType;
  Regs    : RegType;

begin {Set_Spool_Flags4}
  fillchar(ReqBuff,sizeof(ReqBuff),0); {Fill Request
                                        Buffer with nulls}
  with ReqBuff do
  begin
    PacketLength:=$0006;          {work with first 6
                                   bytes of buffer}
    SetFlags:=$02;                {initialize SetFlags}
    PrntFlags:=$28;               {Suppress auto form
                                   feed and delete spool
                                   file after printing}
    TabSize:=1;                   {Tab size = 1
                                   character}
    TargetPrinter:=PrntNo;        {Set network printer
                                   number}
    NumCopies:=1;                 {Number of copies = 1}
  end;

  Regs.AH:=$E0;                   {$E0 - Set spool
                                   flags}

  Regs.DS:=seg(ReqBuff);          {DS:SI address of
                                   request buffer}
  Regs.SI:=ofs(ReqBuff);

  Regs.ES:=Regs.DS;               {ES:DI address of
                                   reply buffer}
  Regs.DI:=Regs.DS;
```


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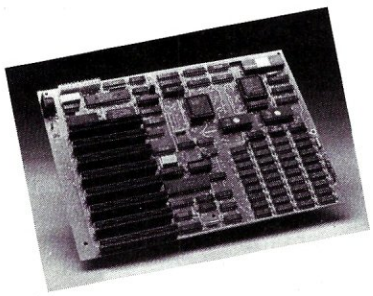

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```
  intr($21,Regs);                    {perform call}
end; {Set_Spool_Flags4}
```

Listing 2. Set_Spool_Flags2

```
procedure Set_Spool_Flags2(PrntNo : byte);
{
  This procedure is an advanced netware 2.0a call and
will turn off the banner page in spool defaults and set
the printer number.

  Process for outputing:
    with LST device closed (local)

    Set_Spool_Flags(N)
    Modify_LST_Device
      Perform output
    Close_LST_Device
}

type
  RequestBuffer = record
    Status     : byte;
    PrintFlag  : byte;
    TabSize    : byte;
    TargetPrint: byte;
    NumCopies  : byte;
    FormType   : byte;
    BannerText : array[1..13] of char;
    LocalPrint : byte;
    TimeOut    : integer;
    DeviceClose: byte;
  end;
  {8086 register type}
  RegType = record
    case integer of
      1 : (AX, BX, CX, DX, BP, SI, DI, DS, ES, Flags :
integer);
      2 : (AL, AH, BL, BH, CL, CH, DL, DH            :
byte);
  end;

var
  Reg         : RegType;       {8086 type registers}
  ReqBuff     : RequestBuffer; {Parameters buffer}

begin  {Set_Spool_Flags2}
  {Initialize buffers}
  fillchar(ReqBuff,sizeof(ReqBuff),0);
  with ReqBuff do
  begin
    Status:=0; {enable defaults}
    TabSize:=1;
    TargetPrint:=PrntNo;
    TimeOut:=0;
    PrintFlag:=28; {suppress ff, delete spool file after
                    printing}
  end;

  {Setup the call}
  Reg.Ah:=$B8; {Network call function - Print Function}
  Reg.CX:=$04; {Change only first 4 bytes in request}

  Reg.ES:=seg(ReqBuff); {ES:BX = address of ReqBuff}
  Reg.BX:=ofs(ReqBuff);
  Reg.AL:=$01; {Network subfunction call - Set
                Defaults}

  intr($21,Reg); {perform the call}
end;  {Set_Spool_Flags2}
```

Listing 3. Modify_LST_Device

```
function Modify_LST_Device:byte;
{
  This function will set the Lst device to the network
printer and return the byte $00 on completion.
}

type
  {8086 register type}
  RegType = record
    case integer of
      1 : (AX, BX, CX, DX, BP, SI, DI, DS, ES, Flags :
integer);
      2 : (AL, AH, BL, BH, CL, CH, DL, DH            :
byte);
  end;
```

... *continued on next page*

Setting the Spooler Control Flags

The spooler control flags are designed to control several spooler options, including banner page printing, deleting the spool file after printing, automatic form feed after printing, and number of copies, among others. There are two routines included to perform these tasks, as shown in Listing 1. (Netware 4.0 Function *$E0*, subsection *$02*, where the *$* indicates hexadecimal values) and Listing 2 (Advanced Netware 2.0 function *$B8*).

The main differences between these two function calls are that the 4.0 call can only set the flags, but it cannot read the current values and cannot set the *TimeOut*, *Local Device*, or *Device Close* values available in Advanced Netware. In addition, there is a difference in the usage of the two routines. With the Netware 4.0 function, you must set the list device, set the spool flags, output the data, and then close the list device. When using the Advanced Netware 2.0 function, however, you must set your spool flags first, then modify your list device, output the data, and close the list device. Modifying the list device before setting the spool flags with the Advanced Netware function will result in unreliable printer settings. This is because the Advanced Netware function requires a call to *Modify LST Device* to actually implement the settings.

The Netware 4.0 Set Spool Flags function *$E0, $02* (Listing 1) provides the ability to set, but not read, several spooler related parameters. These include: suppressing the auto form feed after each print job, deleting the spool file after printing, enabling expansion of tab characters, printing a banner page at the beginning of each job, setting the tab size, selecting a network printer, indicating the number of printed copies, setting the form type, and determining the banner text to be used on the banner pages. These parameters are designated in the variables in the record *ReqBuff*.

The routine provided by Novell does not use the banner text option. If you want a banner page printed at the beginning of your print job you must put the banner text into the variable *BannerTxt*, add the number of text bytes to *PacketLength*, and add *$80* to the *PrntFlags* value to enable banner printing. The text you set in *BannerTxt* must be a null-terminated text string. We also set the variable *PrntFlags* to *$28*, which disables the auto form feed after the print job and enables deletion of the spool file after printing. If you want to use the other *PrntFlags* options you need to add (bit wise OR) the values listed in the record type definition together to obtain the options you want.

The second routine for setting the spool flags uses the Advanced Netware 2.0 function *$B8 Get/Set Default Spool Flags* (Listing 2). We recommend that this newer version call be used, since Novell stated that in the future the older Netware 4.0 calls may not be supported. As mentioned above, this function can set and retrieve the spooler flag values. In addition to retrieving the flags, function *$B8* provides three additional features: indicat-

ing which local port is to be spooled (*LocalPrint*), specifying the time until an automatic *EndSpool* is to be performed (*TimeOut*), and indicating if an automatic *EndSpool* is to be performed (*DeviceClose*). *LocalPrint* can have a value of 0 for LPT1:, 1 for LPT2:, or 2 for LPT3:. All output directed to the specified local port will be spooled to the network printer. *TimeOut* specifies the number of ticks (one tick equals 1/18th second) for the network to wait for the next output before it closes the print job. Lastly, *DeviceClose* should be zero if an automatic *EndSpool* is to be performed when the device is closed (DOS 3.0, 3.1, and 3.2 only). If *DeviceClose* is nonzero, the *EndSpool* will not be automatically performed when the device is closed. You must call this routine prior to calling *Modify_LST_Device.*

Diverting Printer Output

Modify_LST_Device (Listing 3) is used to divert output from the local port to the network printer number specified in the call to *Set_Spool_Flags.* The routine uses Netware function *$DF, $00 Modify_LST_Device* to enable the capture of output information. If the call is successful, *Modify_LST_Device* will return *$00.*

When you have completed a print sequence you will need to cancel the spooling of additional output. The routine *Close_LST_Device* is used to cancel the spooler link established with *Modify_LST_Device.* In *Close_LST_Device,* Netware function *$DF, $01* (Listing 4) is used to perform the closure. If you used the Advanced *Netware Set_Spool_Flags* function and chose to have the device closed after a timeout, you won't need to perform a *Close_LST_Device.* However, if your application is going to call another *Set_Spool_Flags,* you should close the current print job before beginning the new print job. If you are using the Netware 4.0 function you will need to call *Close_LST_Device* before changing devices or finishing your calling routine.

Setting Printer Status

The last routine obtains the status of a network printer. The routine *Get_NPrinter_Status* (Listing 5) provides the ability to determine: if the printer has been halted through the network console; if the printer is off-line; the current form type; and the current printer number. The printer number returned indicates the network printer number that will ultimately receive the output. This may be a different printer than the requested printer number, if the requested printer has been rerouted to a different printer on the network by the network console.

Prior to Standard Netware and Advanced Netware, Version 2.1, have a problem in obtaining these status values. With these older versions you can only obtain the status values if a print job is waiting to be printed or is in the process of being printed. Novell sources say this problem has been corrected in Advanced Netware Version 2.1. However, Netware 2.1 is currently available only for Netware 286 systems. If you are using Netware 86, you will need to wait for Version 2.1.

... continued

```
var
  Reg : RegType; {8086 type registers}

begin  {Modify_LST_Device}

  {Setup the call}
  Reg.AH:=$DF; {Network call function - Print Function}
  Reg.DL:=$00; {Network subfunction call - Start Lst
                catch}

  intr($21,Reg); {Perform the interrupt}

  Modify_LST_Device:=Reg.Al; {return result}
end;  {Modify_LST_Device}
```

Listing 4. Close_LST_Device

```
function Close_LST_Device:byte;
{
  This function will close the catch and queue for
printing and return the byte $00 on completion.
}

type
  {8086 register type}
  RegType = record
    case integer of
      1 : (AX, BX, CX, DX, BP, SI, DI, DS, ES, Flags :
integer);
      2 : (AL, AH, BL, BH, CL, CH, DL, DH            :
byte);
  end;

var
  Reg : RegType; {8086 type registers}

begin  {Close_LST_Device}
  {Setup the call}
  Reg.Ah:=$DF; {Network call function - Print Function}
  Reg.Dl:=$01; {Network subfunction call - Start Lst
                catch}

  intr($21,Reg); {Perform the interrupt}

  Close_LST_Device:=Reg.Al; {return result}
end;  {Close_LST_Device}
```

Listing 5. Get_NPrinter_Status

```
function Get_NPrinter_Status(PrinterNo : byte) :
boolean;
{
  This function will get the status of the server
printer specified by PrinterNo and will return true if
the printer is On-line and not halted, or false if it
is Off-line or halted.  PrinterHalted will be $FF if
the network console halted the server printer.
PrintFormType - will contain the forms type number
currently mounted in the indicated printer.
TargetPrinter - will indicate the routed printer, this
number will be the same as PrinterNo unless the network
console has rerouted the printer.
  Note: This function will only return false in
advanced netware 2.0a and earlier versions when the
printer queue has contents and the printer is off line.
If there are no jobs pending the function will return
an On-line status.
}

type
  {Request buffer format}
  ReqBuffType = record
    PacketLength : integer;
    Command      : byte;
    PrntNo       : byte;
  end;

  {Reply buffer format}
  RepBuffType = record
    PacketLength   : integer;
    PrinterHalted  : byte;
    PrinterOffLine : byte;
    PrinterFormType: byte;
    TargetPrinter  : byte;
  end;
```

Summing Up

These routines were developed in Turbo Pascal and designed to accommodate our applications. There are several options and variations that can be accomplished with these routines to meet your specific needs. Listing 6 is simple example of how to use the new and old *Set_Spool_Flags, Modify_LST_Device,* and *Close_LST_Device* to enable/disable printers and switch between printers.

These routines are only a few of the many functions available to systems integrators working on Novell Networks. You can obtain a complete list of the function calls from Novell by becoming a Netware Affiliate. If you would like information about becoming an affiliate, you should contact Kim Perry or David Hills at Novell, Inc., Mail Stop #BA2MS11, 122 East 1700 South, Provo, Utah 84601; (801) 379-7508. The Affiliate Program is open to most dealers and software developers who want to develop or support software on Novell Networks. The affiliation is free but there is an agreement that must be completed prior to receiving information. □

Ed Rought and Tom Hoops are co-owners of Perpetual Data Systems, a software development and marketing firm located at 63 Keystone Ave., Ste. 206, Reno, NV 89503. Along with their commercial installations, they are the co-authors of a series of books on Pascal and C routines for software application developers to be released shortly by Howard W. Sams & Co., Inc.

```
  {8086 register type}
  RegType = record
    case integer of
      1 : (AX, BX, CX, DX, BP, SI, DI, DS, ES, Flags :
integer);
      2 : (AL, AH, BL, BH, CL, CH, DL, DH            :
byte);
  end;

var
  ReqBuff : ReqBuffType;
  RepBuff : RepBuffType;
  Regs    : RegType;

begin {Get_NPrinter_Status}
  fillchar(ReqBuff,sizeof(ReqBuff),0); {null out
                                        Request buff}
  fillchar(RepBuff,sizeof(RepBuff),0); {null out Reply
                                        buffer}

  with ReqBuff do
  begin
    PacketLength:=sizeof(ReqBuff)-2; {Length of buffer
                                      info}
    Command:=$06; {Get printer Status}
    PrntNo:=PrinterNo; {get status for network printer
                        # PrntNo}
  end;

  RepBuff.PacketLength:=sizeof(RepBuff)-2; {Length of
                                     Reply buffer info}

  Regs.AH:=$E0; {Netware spooling functions}

  Regs.DS:=seg(ReqBuff); {DS:SI - address of request
                          buffer}
  Regs.SI:=ofs(ReqBuff);
  Regs.ES:=seg(RepBuff); {ES:DI - address of reply
                          buffer}
  Regs.DI:=ofs(RepBuff);

  intr($21,Regs); {do the call}

  {analyze results}
  with RepBuff do
  begin
    if (RepBuff.PrinterHalted<>$00) or
       (RepBuff.PrinterOffLine<>$00) or
       (Regs.AL<>$00) then
      Get_NPrinter_Status:=false
    else
      Get_NPrinter_Status:=true;
  end;
end; {Get_NPrinter_Status}
```

Listing 6. Sample Usage Program

```
program Spooling_Demo;

{Include the spooler functions at this point}

begin
  {Set to local mode to start with}
  if Close_LST_Device=0 then;  {Do it blind}

  writeln(lst,'Here I am on the local printer');

  {Change to network printer}
  if Modify_LST_Device<>0 then {Note: could do these
                                blind too.}
  begin
    writeln('Could''nt Modify List device.');
    halt;
  end;

  {Set up network printer & select printer 0}
  Set_Spool_Flags4(0);

  writeln(lst,'Here I am on the network printer 0.');

  if Close_LST_Device=0 then;  {go back to local
                                printer & spool (blind)}

  writeln(lst,'Here I am on the local printer again');

  {Change to network printer}
  if Modify_LST_Device<>0 then
  begin
    writeln('Could''nt Modify List device.');
    halt;
  end;

  {Set up network printer & select printer 1}
  Set_Spool_Flags4(1);

  writeln(lst,'Here I am on the network printer 1.');

  if Close_LST_Device=0 then;  {go back to local
                                printer & spool (blind)}

  {Now using the advanced netware 2.0a call}

  writeln(lst,'Here I am on your local printer for the
last time.');

  {Set up network printer & select printer 0}
  Set_Spool_Flags2(0);

  {Go from local to spool}
  if Modify_LST_Device<>0 then
  begin
    writeln('Could''nt Modify List device.');
    halt;
  end;

    writeln(lst,'Here I am on Network printer 0
      thanks to 2.0a');

  if Close_LST_Device=0 then;  {go back to local printer
                                & spool (blind)}
end.
```

MicroWay's RTOS

A Port of Intel's Real-Time Operating System to the PC

by Stuart Jones, M.D.

Intel is best known as the developer and manufacturer of the 8088, 80286, and 80386 chips—the chips that power IBM and IBM-compatible PCs. The company's reputation for publishing 8- and 16-bit operating systems and language compilers is known mainly to those in the industrial microcomputer arena, and is unknown to most PC owners.

Intel's potent real-time multitasking operating system for 808X-series CPUs, RMX-86, was released in 1980. RMX has been most popular for industrial grade microsystems. These Multibus I- and II-based machines are commonly used for robotics, process control, and laboratory data collection—applications requiring systems software that permits the machine to respond quickly to and synchronize with external events. Two such computers known to this author are used to collect Nuclear Medicine image data from radiation detectors known as gamma cameras. Each gamma ray detected must be processed individually, at very high count rates. Both of these 8-MHz 8086 systems (which can handle up to 80,000 counts per second) use RMX-86. In one of them, currently used in the author's laboratory, RMX manages the operations of three 8086 processors sharing a common Multibus.

RMX-86 is a mature product (the current release is Version 6). Recent versions will run on 8086, 8088, and 80186 processors, and also on the 80286 in real mode; and Intel has just announced RMX-286, which operates in protected mode on the 80286. The company supplies these operating systems both preconfigured (for Intel's own development computer systems) and in user-configurable form, complete with source code. Given the popularity and low cost (relative to industrial systems) of PCs, it was inevitable that RMX would be ported to IBM-compatible equipment.

MicroWay, a company specializing in high-performance hardware and software products, has offered a PC- and PC/XT-compatible version of RMX-86 for several years and has just released an RTOS version configured for the 6-MHz PC/AT. Given the current interest in concurrency for PCs, a close look at a product that legitimately claims to be the first real-time multitasking operating system for IBM-standard micros is both timely and appropriate.

Reviewing an operating system, however, is a job almost ridiculous in its enormity. I admit to intense feelings of inadequacy in confronting the dauntingly large pile of documentation currently occupying a prominent position in my computer workspace. Although I use an RMX-based computer system for Nuclear Medicine every day, RTOS is the first programmable RMX version I have used. In the time allotted, it was impossible to explore the nooks and crannies of the RMX system structure, so rather than an in-depth review, I will try to describe the most important features of RMX, and to distill the flavor of the RTOS version for those interested in exploring further. Specifically, I will try to address:

1. The capabilities of RMX that make it interesting to the prospective application developer;
2. The difficulty of learning RMX (that is, its documentation quality) and getting the RTOS version running on a PC or AT;
3. The ease (or lack thereof) of developing software under RMX, given the tools distributed with RTOS; and
4. The usability and performance of the multitasking features of RTOS.

Because of the size and complexity of RMX, this review will be published in two parts. This first part will explore the generic features and facilities of RMX—those found in any preconfigured version. The second part to be published later this year will examine the peculiarities of the MicroWay implementation, as well as offering some hands-on experience and benchmarks.

The Structure of RMX-86

As operating systems (OS) go, RMX is relatively complicated—it is more complicated than DOS, but not nearly as complicated as many minicomputer or mainframe systems.

Like DOS, RMX is put together as a series of layers (Figure 1). Each layer may call upon services provided by those below it.

The bottom layer, the Nucleus, manages task prioritizing, scheduling, and synchronization, as well as intertask communication. It also manages all hardware and software interrupts, including those from the system's clock-timer.

The next two layers up are the Basic I/O System (BIOS) and the Extended I/O System (EIOS). These manage mass-storage data files in a device-independent manner. Specific hardware is supported via drivers (as in other OSs), though only two of these—for the system keyboard and display—must be preconfigured into the BIOS. The Application Loader, which manages transfer of programs and program overlays between mass storage and main memory, is considered to be part of the EIOS.

Above the EIOS sits the Human Interface, which handles interactions between the lower levels of RMX and terminal devices. This layer implements the RMX file and directory structure on mass storage. The Human Interface provides facilities for multiuser operation of RMX via separate terminals, complete with user numbers, separate user main memory workspaces, and file directories, file access security, and so on.

The next-to-last layer up is the Universal Development Interface (UDI). This provides system calls for file access, system date and time, and memory allocation—services also provided by lower levels. The function of the UDI is to hide the details involved with the lower-level system calls, and thus facilitate application development. It is possible to develop a UDI that runs under a non-RMX, 808X operating system. This permits a non-real-time/multitasking RMX application (e.g., an editor, compiler, or link-editor) to run under the foreign OS. In fact, such a UDI for DOS is supplied by MicroWay as an adjunct to RTOS. (I suspect that facilitating cross development on single-user systems is a major reason for the UDI.)

The topmost layer consists of all user-written applications, as well as the utility programs provided by Intel for RMX, and RMX's program development facilities.

Resource Management and Jobs

RMX manages system resources, including tasks, as objects. Each is assigned an identifying, unsigned, 16-bit token or identifier at the time of creation or definition. Tokens may be passed freely among tasks, giving the software designer considerable latitude.

In addition to tasks, other objects recognized by RMX include memory segments; semaphores, mailboxes, and regions (used for intertask communication and synchronization); files on mass storage; and jobs. Composite objects can be created from these categories. It is also possible (although very ambitious) to create both extension objects and the system services necessary to manipulate them.

A job consists of one or more tasks, with associated other objects, a memory pool (assigned when the job is created), and an object directory. When the Human Interface initializes during the RMX bootstrap process, it creates an interactive job for each terminal. This becomes the root job for that console; all other jobs (e.g., applications programs) run thereafter are descendants of the root job, and therefore draw memory from its memory pool. Since current RMX versions do not offer virtual memory support, this limits the practical number of simultaneous users on an 808X computer to three or four.

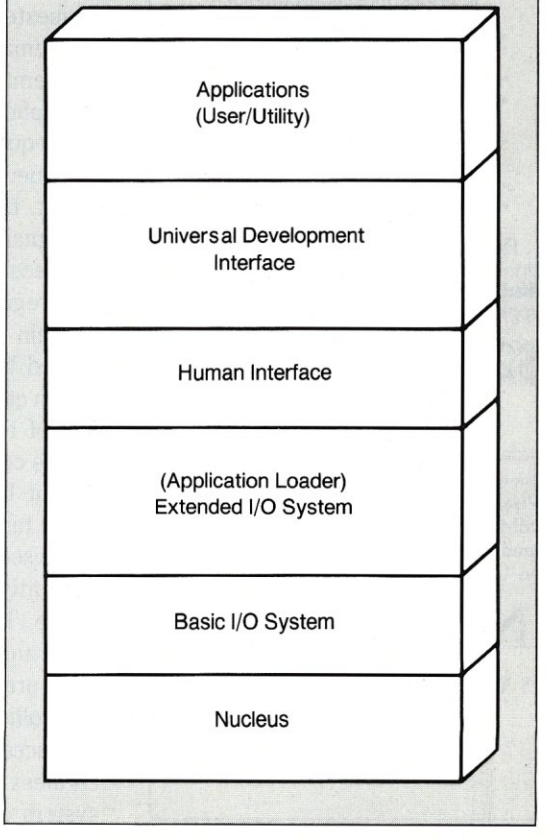
Each job has a root task that creates any other tasks (and jobs) related to the job. Such descendant tasks can be passed other resources at the time they are created, either as messages through mailboxes or by looking up their own tokens in the object directory. Each job is assigned a maximum priority level for any of its tasks at the time the job is created.

Task Switching and Synchronization

Each task is given a priority level ranging from 0 (highest) to 255 (lowest). Levels 0–127 are reserved for interrupt handlers and interrupt tasks. Task priority is assigned at the time of creation and may be subsequently altered by the task itself or by another task possessing its token. The maximum priority that can be assigned to a task is limited by that of its parent job. This limit does not apply to interrupt-related tasks.

A given task occupies one of five possible states: (1) running, (2) ready, (3) suspended, (4) asleep, or (5) asleep-suspended. A suspended task is memory resident, but it can-

Figure 1. RMX System Diagram



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not run until it is resumed by another task or an associated interrupt. Task suspensions can be nested; each nested suspension must be counteracted by a resumption before the task can again become ready. An asleep task is either waiting for a request to be granted, or has put itself to sleep for a specified amount of time via a system call. An asleep task can also be suspended (thus entering the asleep-suspended state); if its request is granted or its sleeping time expires before it is resumed, the task then enters the suspended state.

As RMX is distributed by Intel, task switching is entirely event-driven; that is, there is no inherent time-slicing mechanism to apportion CPU time between tasks. Instead, task switching will occur only if a higher-priority task becomes ready, or if the current task goes to sleep, suspends itself, or deletes itself. However, specific RMX configurations typically do implement time slicing via the system clock-timer interrupt service routine.

Task synchronization is handled using the semaphore and region objects. The semaphore has an associated queue of tasks. Each task has requested one or more "units" from the semaphore. The units are sent to the semaphore by other tasks. If the semaphore has enough units to fulfill the request of the task at the head of the queue, that task becomes ready. If not, that task (and others behind it) remains asleep until enough units are received.

A region guards access to the area of main memory used to store data shared between tasks. It also manages a queue of tasks waiting for control of the region. Once a task receives control, it becomes ready and cannot be suspended or deleted by other tasks; its priority is temporarily raised to equal that of the task currently at the head of the "ready" queue. This ensures that the shared data cannot be corrupted by inadvertent pre-emption of the currently controlling task by another task that has access to the data. However, careless use of regions can lead to system deadlock. It also can represent a security risk on multiuser RMX installations if it creates a task that cannot be deleted, even when a user logs off. Therefore, Intel recommends that regions be used only as part of extension objects (wherein such use can be controlled by system programmers), or by tasks directly involved in RMX operation (i.e., not involving the Human Interface).

Intertask communication is managed using the mailbox object. A mailbox manages two queues: one consisting of tasks waiting for messages and the other of messages waiting for tasks. Each message is a token and messages in the queue are passed to tasks on a FIFO basis.

For semaphores, regions, and mailboxes, the queue of waiting tasks may be arranged either in order of task priority or in order of arrival (i.e., FIFO). The ordering mechanism used is selected at the time the semaphore, mailbox, or region is created.

Tasks requesting access to a region, a message from a mailbox, or units from a semaphore may either wait for the request to be filled (thus entering the asleep state) or continue if the request cannot be filled, receiving an exception code if the request was not honored.

Interrupt Handlers and Tasks

The RMX-86 Nucleus provides extensive services for managing hardware and software interrupts. A user-designed interrupt handler may be bound to any of the 808X/80X86 interrupt levels, although certain levels (particularly that assigned to the system clock) are reserved by RMX. When the handler is assigned, an interrupt task that finishes the interrupt processing begun by the handler may also be assigned to the same or a different level—the handler passes control to the interrupt task by asserting a software interrupt. RMX assigns a default priority, equal to double the level number, to an interrupt handler, or task according to the interrupt level to which it is assigned for interrupt levels

0–3FH. Thus, every even priority level from 2 to 128 is preassigned.

Interrupt handlers are limited in terms of the system calls they may invoke, and also (practically speaking) in the amount of processing time they can tie up, since other lower-priority interrupts are disabled while the handler is running. An interrupt task, however, can continue processing while other interrupts are serviced, and can invoke services (e.g., I/O calls) forbidden to handlers. Invocations of interrupt tasks can be nested up to a maximum count, which is defined when the interrupt handler is bound.

Exceptions

As befits an OS of such complexity, RMX provides facilities for managing situations where something has gone wrong, either due to programmer error or to an environmental problem that could not reasonably have been anticipated. As each task or job is created, it is assigned (by default) or assigns itself a procedure for managing exceptions. This not only provides for robust and context-sensitive error handling, but also represents a mechanism for circumventing Intel- or RMX-configurator-imposed limitations (since an exception handler can choose to ignore certain exception conditions). A job that does not assign its own exception handler inherits that of its parent job (e.g., the system exception handler, where no other job has specified otherwise). If a job is assigned a different exception handler, this becomes the default for all descendant tasks or jobs.

In addition to its exception handler, a task or job is assigned an exception mode. This defines when control will be passed to the exception handler—for every exception, for no exception (effectively disabling the handler), for programmer errors only, or for environmental conditions only. The choice of exception handler or mode can be reassigned via system calls.

In addition, most RMX system calls can return an exception code, which is returned to the calling task (and which may be passed to the exception handler, if it is enabled to manage the condition being signaled). Certain of these codes are informational only, and will not invoke a handler.

The I/O System

I/O services are provided via system calls to the BIOS and the EIOS (or to the UDI, if desired). BIOS system calls require specification of a number of details (e.g., buffer addresses and sizes) that are routinely provided for by EIOS calls. However, BIOS calls typically involve less overhead than EIOS calls, and may allow processing to proceed concurrently with I/O. EIOS calls put the calling task to sleep until I/O is complete. However, the EIOS does permit assignment of logical names to physical files and devices, easing the programmer's burden. As mentioned above, UDI calls can be used to provide limited, stereotyped I/O services for user applications that may need to run in an 808X cross-development environment (precluding, as well, the use of RMX real-time and multitasking capabilities by such applications).

The BIOS incorporates mechanisms for I/O with named files on mass storage, physical files (e.g., line printers), and stream files (temporary mass storage files used for passing data from the output of one task to the input of another, similar to pipes in UNIX). The BIOS implements communication with these files in a device-independent manner. As for most other OSs, the grubby details of getting the data to and from physical media are managed by device drivers.

An unusual feature of RMX is its dynamic device configuration. Using utility programs, different device drivers may be attached to or detached from the BIOS while RMX is running. Indeed, the system device may be dynamically respecified (although this does involve rebooting) if the supplied bootstrap mechanism or a supplied utility program provides for this. As mentioned above, the only devices that need to be

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preconfigured into RMX are those for the default system console.

Terminal I/O and File Management

Console I/O is managed by the Human Interface, which also provides for file access control and directory management, and for running programs via a command line interface (CLI). Individual users are assigned user ID numbers that identify their owned files and directories—a scheme used by most multiuser OSs.

The file structure managed by the Human Interface is hierarchical and quite similar to that provided by UNIX. Every mass storage device is given a logical name when attached (a string expression bracketed by colons—e.g., *:w0:* for the first fixed disk drive, *:sd:* for the default system mass storage device). Each mass storage volume has a root directory with subdirectories, the tree directory structure used by so many operating systems. As for UNIX, user directories are listed in the */USER* directory, with a different subdirectory for each user number. The system manager directory and privileges are password-protected, although the password is initially set to a null string. On a new installation, the system manager must define "terminal definition files" for any additional terminals to be used (in addition to the PC keyboard and display in the case of RTOS), and set up user ID numbers and directories for other users of the terminals. This is unnecessary for RTOS if only the PC keyboard and display will be used for interaction with the system.

As is clearly evident from the system documentation, RMX is designed to run on hardware incorporating at least one fixed disk drive that can serve as the system device (*:sd:*). Devices with removable media (e.g., floppy or cartridge hard drives) must be attached before a volume may be accessed, and detached before that volume is removed. Otherwise, the file structure on that volume and the next one inserted may be corrupted! A volume cannot be removed from the system device without rebooting. (Shades of CP/M-80 V1.4!)

As noted above, on start-up the Human Interface creates an interactive job for each terminal. This job is assigned a specific memory pool (about 225K net under RTOS). Human Interface commands or user programs are limited to the initial memory partition. This can be altered by the system manager, however, if applications require more memory. RTOS applications (including language processors) typically make heavy use of overlays to permit operation in limited memory space.

Intel supplies a comprehensive set of utility programs for managing files, formatting and verifying volumes, setting system date and time, running batch files, and so on. MicroWay supplements these with additional utilities.

The MicroWay Product

The preceding sections are an all-too-brief review of the features and structure of an extremely complicated operating system. In this discussion, I have alluded to some specific RTOS features, more of which will be described in the second part of this review.

RTOS is directly distributed only by MicroWay. Prospective users are warned about possible hardware incompatibilities. At present, RTOS is certified to run only on the 256K-motherboard PC, all 8088-based XTs, and the 6-MHz AT by IBM equipped with the standard monochrome/printer or color graphics display adapter and the IBM fixed-disk controller. The Maynard Inc. add-on hard disk and clock controllers are supported for the PC. With the sole exception of the Compaq 8088-based portable, no other hardware, and no PC/XT/AT clone, is likely to run either RTOS or its companion utility programs. The target PC, XT or AT must have a math coprocessor (8087 or 80287) installed. An RTOS

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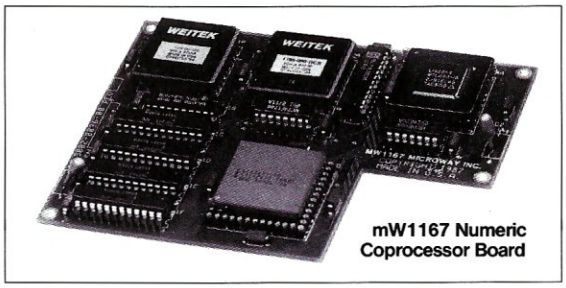

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The compilers are presently available in two formats: Microport Unix 5.3 or MS-DOS as extended by the Phar Lap Tools. MicroWay will port them to other 80386 operating systems such as OS/2 as the need arises and as 80386 versions become available.

The key to addressing more than 640 kbytes is the use of 32-bit integers to address arrays. NDP Fortran-386 generates 32-bit code which executes 3 to 8 times faster than the current generation of 16-bit compilers. There are three elements each of which contributes a factor of 2 to this speed increase: very efficient use of 80386 registers to store 32-bit entities, the use of inline 32-bit arithmetic instead of library calls, and a doubling in the effective utilization of the system data bus.

An example of the benefit of excellent code is a 32-bit matrix multiply. In this benchmark an NDP Fortran-386 program is run against the same program compiled with a 16-bit Fortran. Both programs were run on the same 80386 system. However, the 32-bit code ran 7.5 times faster than the 16-bit code, and 58.5 times faster than the 16-bit code executing on an IBM PC.

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version for the 8-MHz PC/AT and clones is not expected to be ready for 4–6 months. Microway has a current user base of more than 500 installations (nearly all on XTs, but with a growing number of ATs) and appears committed to supporting and developing this product.

The base RTOS package includes the configured RMX with all standard utility programs and object code libraries, as well as the ASM-86 assembler, and MicroWay's own 87-DEBUG. Language translators for Pascal (a pretty much ISO standard implementation, according to the documentation), FORTRAN (1977 standard, also an apparently complete implementation) and PL/M-86, as well as MicroWay's own ETX programming editor and the aforementioned MS-DOS-specific UDI, are available as options.

Documentation is supplied in 8½-by-11 inch, three-hole punched form. In addition to their own manual (1½ inches thick, and clearly written, with some specific examples of terminal dialogue and programming of multitasking applications), MicroWay distributes the Intel ASM-86 and Getting Started with RMX-86 manuals. Additional Intel manuals for the Nucleus, UDI, BIOS, and others, are readily available from MicroWay or Intel. The Intel Manuals appear well-organized and clearly written, but are definitely aimed at the technically knowledgeable user.

RTOS is designed to coexist on a fixed disk with DOS. Indeed, the RMX system loader runs only from DOS. This is a minor nuisance if RMX is being used as the principal operating system for a special project, but it is a major advantage if the target machine is to be used for DOS applications as well. Utility programs are provided to move data files between RMX and DOS, as well as for backup of the original RMX-format distribution diskettes under DOS. The system files are compact enough that RTOS can be run using two 320K floppy disk drives. This is neither desirable nor recommended, however, though the MicroWay manual briefly describes how to navigate with this configuration.

Current pricing of this product is very reasonable given the complexity and support requirements of RMX. A complete configuration, with all available languages, the ETX editor, and the DOS UDI, retails for $2,500. □

Dr. Stuart Jones is a Nuclear Physician with 22 years experience working with computers of all types. He is Chief of Nuclear Medicine at Lehigh Valley Hospital Center in Allentown, Pennsylvania.

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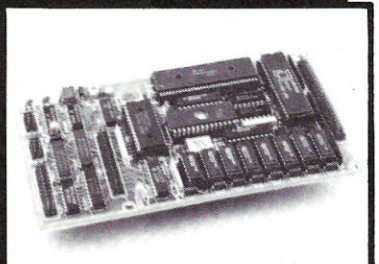

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3270 Gateways

LAN workstation users sometimes need a connection to an IBM mainframe. When such a connection is required, one of the easiest ways to make a connection is with a 3270 gateway.

The IBM Mainframe Network Environment

In a typical IBM mainframe network environment, terminals are connected to a cluster control unit via coaxial cable. The cluster controller, in turn, is connected to a front-end processor attached to the host computer (Figure 1).

A confusing aspect of the IBM mainframe environment is that it uses a numeric naming scheme to identify the equipment. Table 1 identifies the common IBM equipment numbers, with descriptions.

Initially, a PC was added to an IBM network by installing a Digital Communications Associates (DCA) IRMA card in the PC. This permitted a coaxial connection between the PC and the cluster control unit (Figure 2) which allowed the PC to emulate a 3278 terminal. This was very workable where there was a cluster control unit to attach to, however, this is not always the case.

Therefore, in addition to the IRMA-type connection, other links were developed that enabled a PC to emulate both a 3278 workstation and a 3274 cluster control unit (Figure 3). This approach was unpopular because it tied up a large portion of a front-end processor for only one terminal.

The introduction of PC LANs created an environment where the LAN workstations could share a host connection. All that was needed was a LAN gateway that emulated the cluster controller (Figure 4).

There are two fundamental reasons for using a gateway: terminal emulation and file transfer.

Terminal Emulation

There are some differences between a PC emulating a 3278 or a 3279 terminal and the real thing. First, the PC's display is not the same as the display on a 3270 terminal. Messages displayed on status line 25 are different; for example, a 3278 terminal uses a "lightning bolt" symbol with a number beside it to indicate a communication check. The PC cannot readily produce the lightning bolt symbol and therefore other symbols must be used.

Second, the keyboards of the PC and the 3270 terminal are different. Several keys on a 3270 are critical to the execution of applications on the IBM mainframe. For example, many programs require Program Function keys to select items from menus or to invoke certain functions in editors or applications. The PC's 3270 emulation must remap the PC keyboard to provide these functions, which often leads to awkward keystrokes.

A third factor is how much memory the emulation software demands. If the emulation requires too much memory, there may be insufficient memory space to run an application when you "hot-key" between the 3270 terminal emulation and DOS.

File Transfer

Originally, programs to transfer files between IBM mainframes and PCs required starting an edit session on the mainframe and capturing the "listing" file on the PC during the edit session. As a result, you often got edit prompts in addition to the file data.

When IBM introduced its 3270PC, it combined a personal computer with a 3270 terminal. Included was a file transfer program that is often referred to as IND$FILE (the proper name is the IBM 3270 File Transfer Program). We like to use this file transfer software because the drivers for this program are generally installed on the IBM mainframe, and because they work well. The IRMA file transfer programs, FT/TSO and FT/CMS, are also widely distributed.

In addition, there are third-party file transfer programs, including one popular program, Tempus-Link. It makes files stored on the mainframe appear as if they were on a virtual disk drive on the PC. Using such pro-

Table 1. Common Equipment Numbers and Descriptions

Terminals and Printers	
3278 Model 2	1920 character, 24 PF keys
3279 S2A	1920 character, four colors
3279 S2B	1920 character, seven colors
3279 S3G	2560 character, seven colors, presentation graphics, extended functions and programmed symbols
3287 Model 2	120 characters per second
Control Units	
3174	New controller
3274 51C	For SDLC line control 32 devices
3274 61C	For SDLC line control 32 devices

grams, file transfer is accomplished by doing a file copy between the physical disk on the PC and the virtual disk on the mainframe.

LU Pooling

In the IBM network, a connection between a terminal and the host is referred to as a "Logical Unit" (LU). Each terminal requires one LU. Therefore, a cluster control unit set up to support 32 LUs can have up to 32 terminals connected to it using coaxial cable.

> Some application software uses LU assignments for security . . . a gateway should use pooled and assigned LUs.

When a gateway is in use, the LUs can be pooled. Our experience has shown that a 32-LU gateway can support approximately 50 workstations. The key is to make sure that no more than 32 users can be logged onto the host through the gateway at one time. When a user accesses the host through the gateway, an LU is assigned to the workstation. The next user to log on gets the next available LU. If the first user logs off, the LU he or she was using is returned to the pool and becomes available for the next user to request a host connection.

While this can be an advantage, it is sometimes necessary to assign specific LUs to specific workstations. Some application software use LU assignments for security. Therefore, a gateway should be capable of using pooled and assigned LUs. The gateways we use on the LANs we design include: NAS SBS, Eicon SDLC and x.25, INS, IRMA-

Figure 1. Typical IBM Network Environment

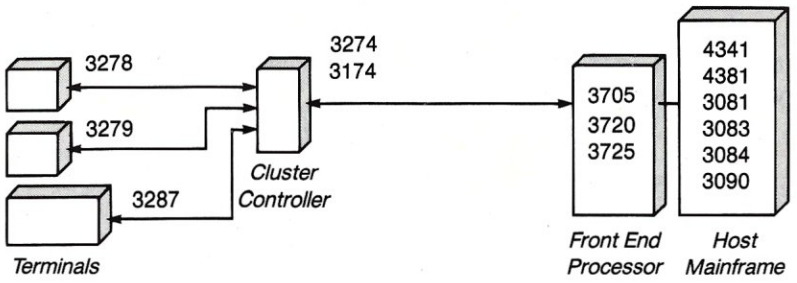


Figure 2. PC connected to IBM LAN via an IRMA card.

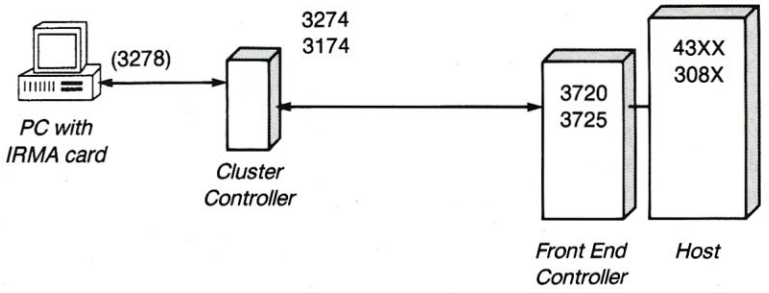


Figure 3. PC connected to IBM via 3278/3274 Emulator card.

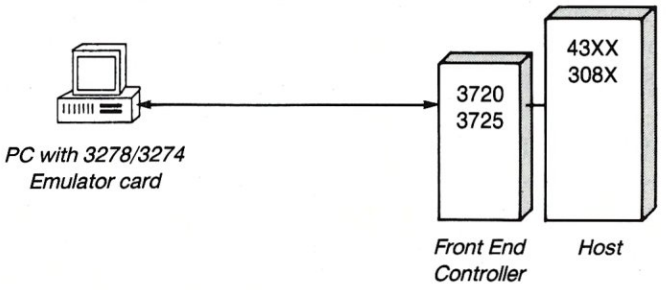
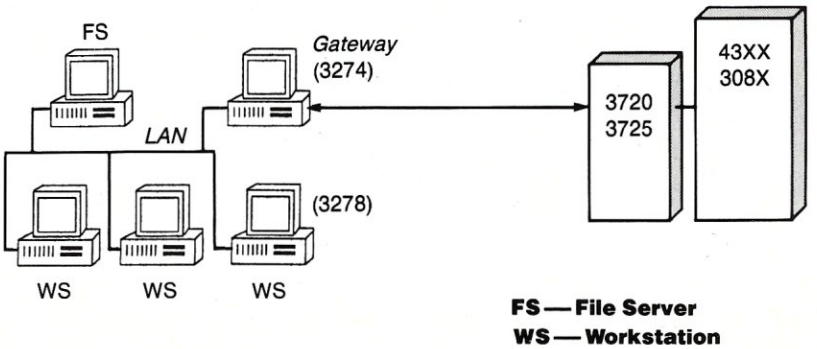


Figure 4. PC LAN connected to IBM system via a gateway.



LAN, and Novell/CXI.

We select gateways to meet specific customer requirements, based on an analysis of both the customer's host and LAN environment. The following sections offer a brief summary of the gateways and their salient features.

The NAS SBS Gateway

National Advanced Systems (NAS) offers a unique gateway product called the Single Board Solution (SBS). The SBS gateway supports the Novell IPX (Internetwork Packet Exchange) allowing users to access the gateway across a bridge. This cannot be done with NetBIOS gateways.

Further, software also is available that enables the SBS hardware to operate as a 3770 Remote Job Entry (RJE) gateway. While many users want terminal emulation, there is probably no faster file transfer facility than RJE.

The Eicon SDLC Gateway

Eicon offers an excellent gateway product that works well, and is perhaps the easiest gateway to install. Of all the available gateways, it provides the best 3279 3GS and IBM Application Programming Interface (API) emulation. The Eicon gateways also supports x.25 network connections.

Eicon's technical support is excellent. Recently, we found a file transfer problem and Eicon programmed a repair that was sent out the next day by Federal Express. Most gateway manufacturers take weeks to even acknowledge a problem.

The INS Gateway

INS offers gateways for IBM mainframes and for 8100 processors. The 8100 gateway is the only one we know of for 8100 processors. The INS gateways are moderately easy to install and function well.

The IRMA Gateways

Digital Communications Associates offers an IRMA gateway that is as good as its coaxial attach card. It is moderately easy to install and works quite well.

The Novell/CXI Gateway

The Novell/CXI gateway works, but it is the most difficult to install and lacks technical support. The documentation is obscure at best, and it can be very hard to find exactly where you should be in the installation process.

Technical support may improve in the future, since Novell recently acquired CXI. The difficulty in getting answers or product from CXI may be related to the new organizational problems encountered during this period of transition.

Table 2. An AUTOEXEC.BAT File to Load an Eicon Gateway

`ANET3`	Load Novell network shell
`NETBIOS`	Load NetBIOS
`NABIOS SRV IBMHOST /32`	Load NABIOS for gateway server
`SDLC START`	Start SDLC gateway component
`SNA START`	Start SNA gateway component

Table 3. The Workstation Program Needed for an Eicon Gateway

`ANET3.COM`	Novell workstation shell
`NETBIOS.COM`	Novell NetBIOS emulation program
`NABIOS.COM`	Eicon Network Adaptor BIOS
`SDLC.EXE`	Eicon SDLC program
`SNA.EXE`	Eicon SNA program

Installation Tips

While gateway manufacturers say that their gateways can be used in a non-dedicated workstation, we do not recommend this. We believe that the gateway should be installed in a dedicated workstation, and that the workstation should be located in a secured area.

With a non-dedicated workstation, a user might run an application that hangs the computer and requires rebooting the machine via the ALT + CTRL + DEL keys. This also reboots the gateway, which causes the active host sessions to be dropped. In addition, our experience is that when a PC containing the gateway is left in an accessible area, someone is going to come along, not realize that the PC is running the gateway, and reboot the system to run another application.

We believe that the gateway should be installed in a dedicated workstation, and that the workstation should be located in a secured area.

At HallComm NetWork Services, we have designed a special communications server to house 3270 gateways. It is diskless, and boots from a PROM installed on the network interface card. The communications server does not look like a PC, and therefore users leave it alone. Regardless of where the gateway is housed, it should be designed so the gateway is automatically initialized whenever the communications server is started. We accomplish this either through an AUTOEXEC.BAT file or by logging on a specialized

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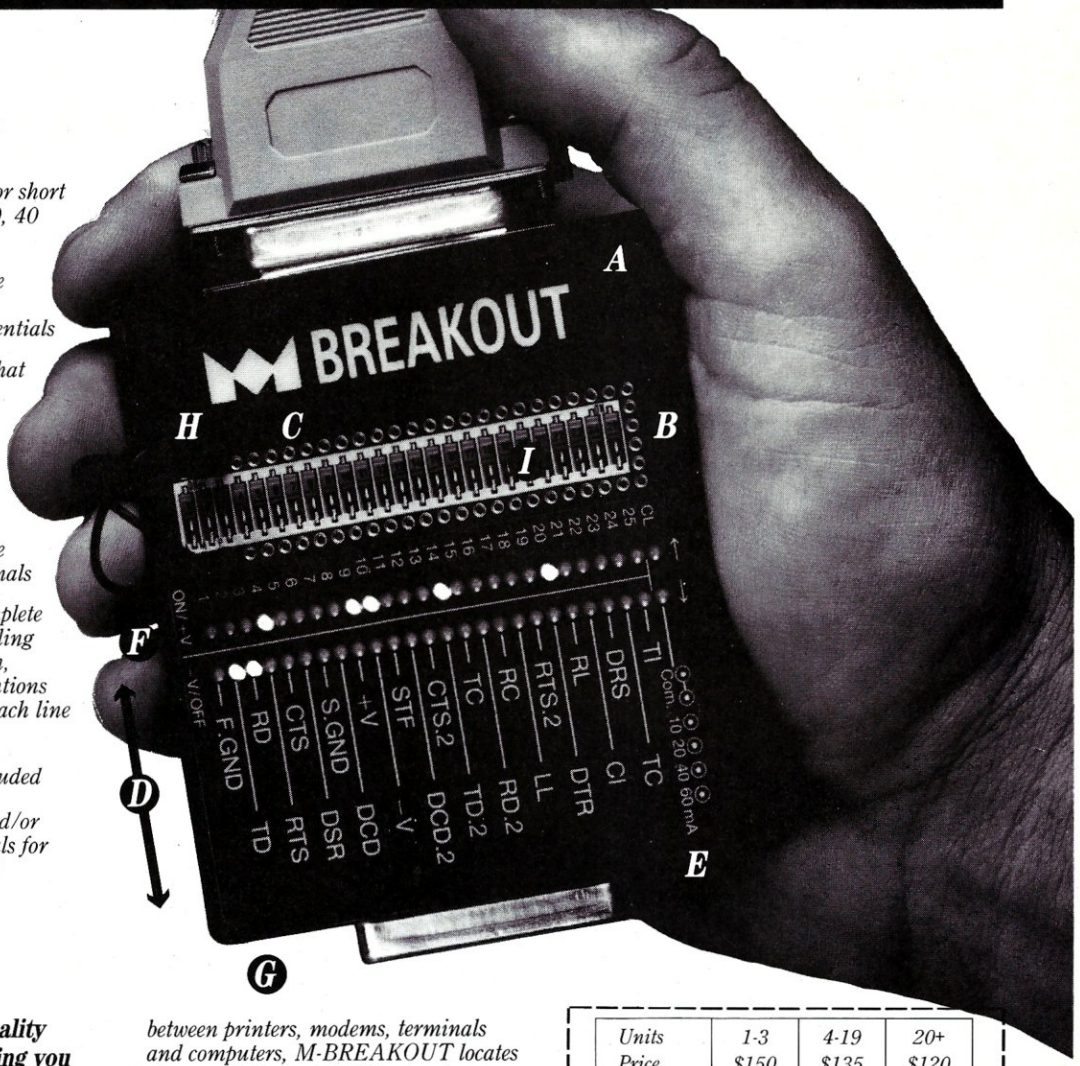

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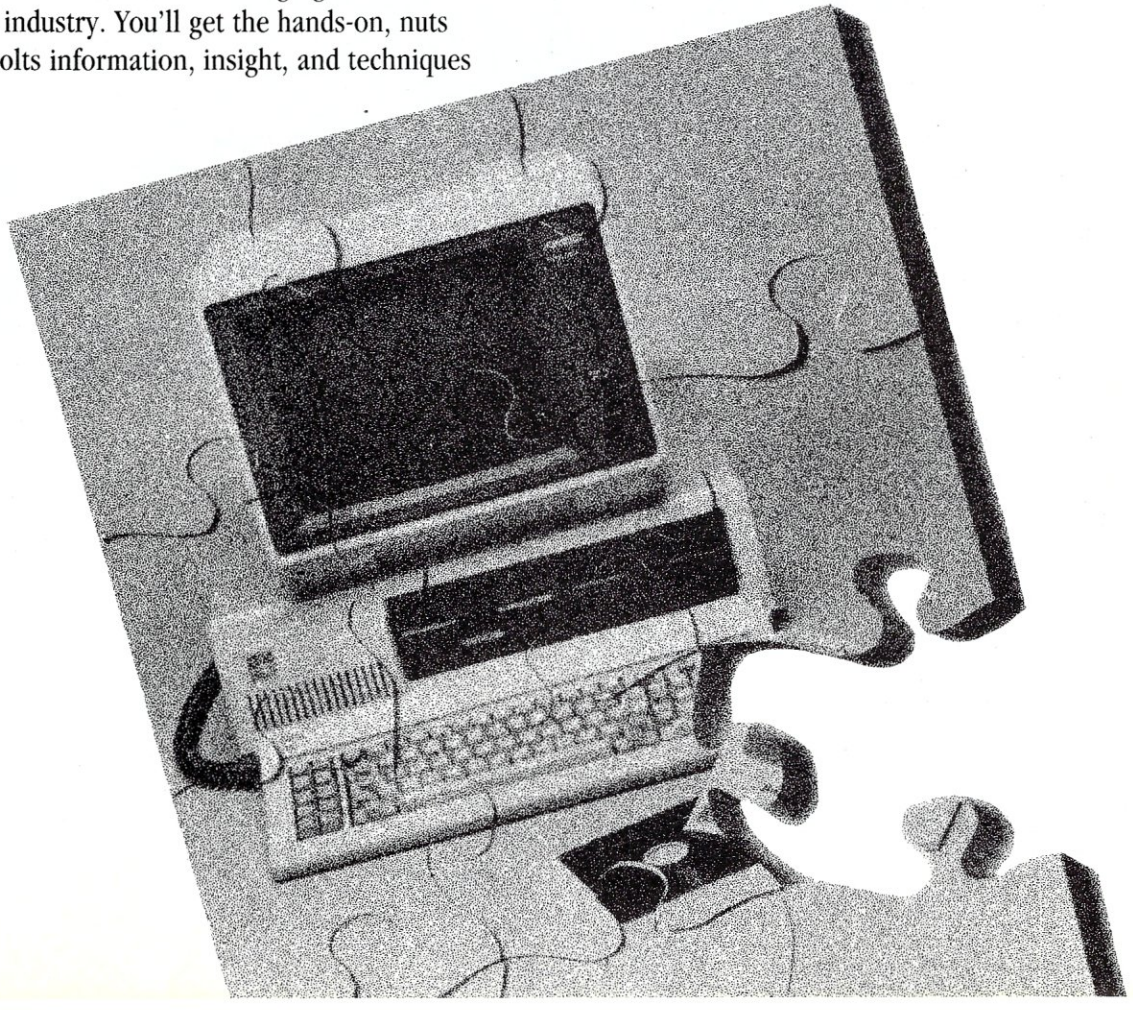

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user who initializes the gateway and then logs off. The AUTOEXEC.BAT approach is easy, but requires that the files be stored where they can be accessed by the gateway (usually on the floppy drive of the gateway workstation or in the LOGIN directory). The advantage of the specialized login ID is that the gateway files can be accessed from the file server and you can see if the gateway is active by checking the status of the gateway user.

Table 2 is a sample of the AUTOEXEC.BAT file we use to load and start an Eicon gateway. When using this approach, the programs shown in Table 3 have to be available to the gateway workstation.

To achieve the same result, but log in a user called Eicon, the AUTOEXEC.BAT file might be:

```
ANET3
NETBIOS
F:
LOGIN EICON
```

The user, EICON, would then have the following statement in its individual user login script:

```
MAP G:=SYS:COMM/EICON
DRIVE G:
EXIT "START.BAT"
```

The G: drive would be the drive that was mapped to the directory with the Eicon software. START-.BAT could then be:

```
NABIOS SRV IBMHOST /32
SDLC START
SNA START
LOGOUT
```

Similar approches can be created for most manufacturers' gateways.

Another consideration is the hardware interrupt used by the LAN and gateway interface cards, both housed in the same communication server or workstation. Some LANs require the LAN interface cards to use interrupt 3, e.g., Ethernet with Novell, and some gateway cards are preset to interrupt 3 and are not alterable, e.g., INS. There are "patched" NetWare shells that use another interrupt. While this gets around the problem, many vendors will not or cannot support such patched shells.

Also, some file transfer software use the API (Application Program Interface). APIs can be different, and a file transfer written for one API may not work with another API. One popular API is the IBM API. This API uses software interrupt 7A (hex). Some technical reference manuals indicate that 7A is unassigned, however IBM uses 7A for the API and Novell uses 7A for the workstation shell. Thus, there can be a conflict in using the IBM API in a gateway on a Novell LAN.

Again, there are LAN shells that use interrupt 7B rather than 7A.

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This patch will allow you to run file transfer packages that use the IBM API, and can be used to connect 3270PCs to a network. However, the previous caution about patched shells applies here as well—you may not be able to get vendor support for a patched shell.

Conclusion

There are several gateways available that can be used to enable a PC user to access an IBM mainframe. No matter what you choose, points to consider in selecting a gateway include:

- What is the host application to be accessed?
- What terminals do you have to emulate?
- What file transfer has to be done?
- Does the gateway have to be accessed across a bridge?
- What speeds do you want to use?

The gateway that will work best for you will depend upon your requirements. □

Michael Cherry is Vice President of Technical Support for HallComm Network Services (HNS), a company devoted exclusively to designing and implementing LAN systems.

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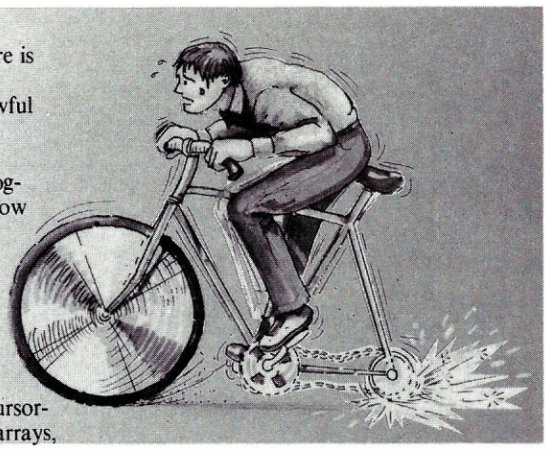

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by A. G. W. Cameron

Mini-supercomputers on the Desktop

Desktop number crunching will be revolutionized this spring. But before exploring why, let's start by defining some terms. The definition of "supercomputer" is changing gradually with time. Currently, it means a machine change with a computing power of 10 mflops (millions of floating point operations per second) or more—quite a lot more for the best known supercomputers from Cray. This benchmark is evaluated by seeing how fast the machine can carry out operations on a 100 × 100 matrix, which gives a reasonable mix of the most common floating point operations (the LINPACK benchmark). Usually, it also means a cost of at least $1,000,000.

There also has sprung up a new class of machine, the mini-supercomputer. Currently, this means a machine with a computing power in the range 1 to 10 mflops. The cost starts at $100,000 and escalates swiftly. This processing power is about to come to desktop micros in the form of the Weitek XL-Series coprocessor boards. But the cost will be just a shade over $10,000.

Desktop workstations have already been pressing at the bottom of this performance range. My Sun 3/260 workstation with floating point accelerator (based on the Weitek 1164 and 1165 chips) is rated at about 0.5 mflops. The new Compaq Deskpro 386/20 with the Weitek 1167 coprocessor board installed (see "The Scientific Computer User," *M/SJ*, February 1988) should have a performance of about 0.7 mflops. The new Sun 4/260 workstation is rated at 1.1 mflops and is based on the SPARC (Scalable Processor ARChitecture) technology, coupled with the Weitek 1164 and 1165 chips. This spring, the technology is scheduled to appear in the form of a coprocessor board from Definicon Systems (see "The Scientific Computer User," *M/SJ*, January 1988). Thus, by some technical reckoning, desktop machines will cross the mini-supercomputer threshold with the appearance of the Definicon board. But a much more powerful coprocessor board will appear at about the same time (it is already being sampled) that utilizes the XL-Series chips from Weitek.

The Weitek XL-Series

The XL-Series of boards are technically called "attached processors." The XL-8000 consists of an integer processing unit and a program sequencing unit. The XL-8032 adds to these a 32-bit floating point processing unit. The XL-8064 adds a 32-bit/64-bit floating point processing unit. The XL-8032 is available from Weitek as a two-board development unit for PC AT/Xenix machines and from Mercury Computer Systems as single, add-in boards for the PC AT operating under DOS, as well as for Sun and Apollo workstations and for DEC MicroVAXen. Weitek expects to have 8064 development units available in the first quarter of this year. Mercury has stated that its MC3200 (the XL-8032 in Mercury adaptation) is the first member of a family of upward-compatible products and that the addition of a 64-bit coprocessor is expected to come off the drawing boards in the not-too-distant future.

In addition to the integer and floating point processors, the XL-Series processors include a 32-element data register file and a 33-element program control stack. The floating point chips also have a 32-element floating point register file. These register files allow memory access to be reduced by maintaining variables and, where possible, passing parameters in registers rather than in RAM. The processors have a RISC (Reduced Instruction Set Computer) architecture, even though their instruction set is rather large. The integer instructions, except multiply and divide, complete in a single cycle. The floating point instructions, except divide, complete in no more than four cycles. The floating point units are pipelined so that a new operation can begin every cycle. The various functional units operate in parallel so that floating point, integer, memory, and control operations can all take place at the same time. Thus the XL-Series boards are designed to be vector processors. However, if they were only vector processors, they would form rather inflexible array processors, running as slave computers under a host. Actually, they can be run that way, but the element that makes them of great interest is that they are also designed to be efficient scalar pro-

cessors and can run as independent computers if desired, with the exception of the interface to the host that handles operating system services.

There are separate code and data buses on the XL-Series processors and each has a 32-bit address. The separation of the code from the data operations effectively doubles the bus bandwidth of the machine. The 8064 processor may be configured for either a 32-bit or a 64-bit data word, with corresponding data bus width. The latter allows double-precision floating point words to be loaded or stored in a single bus operation.

> The Parallelizer rearranges the instruction flow so that as many operations take place concurrently as possible.

Now let's consider floating point performance. The XL-8032 runs at 5 sustained mflops and 25 peak mflops (which gives some idea of the spread between performance in scalar operations and in very efficiently coded vector operations). The XL-8064 runs at 6 sustained mflops and at 20 peak mflops. These peak numbers are ideal values that will almost never be attained in real problems. Tony Funari, an engineer at Weitek, has told me that both the XL-8032 and the XL-8064 have run single-precision LINPACK at 8 mflops and the XL-8064 has run double-precision LINPACK at 13 mflops. The latter performance was achieved using a version of the XL-8064 with a 64-bit data bus; the version of the XL-8064 with a 32-bit data bus, which is essentially the 8032 board with an 8064 chip popped in instead of the 8032, runs the double-precision LINPACK at 12 mflops. Notice that there is only a modest gain to be had in going to the 64-bit data bus.

The software provided by Weitek includes C, Pascal, and FORTRAN compilers from Green Hills Software developed to run in UNIX systems. After passing through a compiler, a program passes through a Parallelizer which optimizes the code for the pipeline features of the processor board, and then it passes through a linker and librarian to produce an executable program. There also is an assembler that can be used to write tightly-coded routines for linking with the output of the higher level languages. Mercury has taken over the C and FORTRAN compilers from Weitek and has rewritten the board interface software so the board can run under DOS or under the operating systems of the various workstations mentioned above.

The Parallelizer is a particularly interesting development. It rearranges the instruction flow so that as many operations take place concurrently as possible. Thus, integer, floating point, and address generation operations can be scheduled to occur simultaneously. The Parallelizer can increase execution speed by up to a factor of two. There are three fields in the instruction word: the sequencer field (8 bits wide), the integer field (24 bits wide), and the floating point field (32 bits wide). Thus, every instruction word can provide operation codes for three parallel operations. A minority of the instructions use more than one of these fields and thus interfere with complete parallelism.

The prices charged by Mercury for its MC 3200 board and related software are $8,000 for the basic AT coprocessor board, including 2 megabytes of memory on board; $1,995 for the Driver/Executive, Linker, Scientific Algorithm Library, and binary run-time license; and $1,500 for a C or FORTRAN compiler. Additional memory is added in the form of a daughter board and costs about $1,000 per megabyte. The daughter board can add 2, 4, or 8 megabytes to the AT version of the board, and up to 16 megabytes to the version for the Sun workstation. The Sun version of the board costs

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about $2,000 more than the above prices. Presumably, the anticipated MC 6400 to come from Mercury will cost a little more than the MC 3200, but probably not much more.

Considering that one can approach supercomputer speeds for these prices, these coprocessor boards will be immensely more cost-effective than either real supercomputers or mini-supercomputers. The number-crunching revolution will get a big boost to a performance level for desktop machines that, just a few weeks ago, I did not think would be reached until the early 1990s.

Weitek manufactures several other numeric coprocessing chips that offer the potential for other fast machines a little later on. Particularly interesting are the 2264 multiplier/divider chip and the 2265 adder chip. These are intended to be used in efficiently pipelined operations; the chip set can maintain 12.5 mflops when pipelined for 64-bit multiplications.

The BIT Chips

From the above descriptions, the reader may get the impression that the future of number-crunching lies in the hands of Weitek. It just so happens that a very fast, competitive, numeric coprocessor chip set also is available now which was developed and is manufactured by Bipolar Integrated Technology Inc. (BIT) of Beaverton, Oregon. The chips use bipolar emitter-coupled logic (ECL) and have both ECL and TTL (transistor-transistor logic) I/O interfaces. The latter devices are slightly slower and cheaper, so I shall only report on the faster, all-ECL versions.

BIT has made a technical breakthrough by reducing the cell size of the chip elements from the dimensions needed in previous ECL chips. This has increased the already very fast speed of the chip and decreased power consumption while allowing denser packing of the elements.

In the Weitek chip sets discussed above, the attainment of a high floating point processing rate depends on efficient pipelining of the operations. In contrast, the BIT chips feature a flowthrough architecture without pipelining. That means that the speeds given below are available for scalar operations and there is no advantage to be obtained in vectorizing the code.

The 32-bit chip set consists of the B3110 multiplier and the B3120 arithmetic logic unit and sells for $640 each in lots of 100. Normally, these chips would be operated in conjunction with the B3210 five-port register file chip, which is organized as 64 18-bit words. The B3110 multiplier performs single (32-bit) and double (64-bit) precision multiplies

> These coprocessor boards will be more cost-effective than either real supercomputers or mini-supercomputers.

at 28 and 22 mflops, respectively (35 and 27 mflops for register-to-register operations). The B3120 ALU (arithmetic-logic unit) performs single- and double-precision adds and subtracts at 40 mflops (53 mflops for register-to-register operations), and performs both 32-bit and 64-bit integer operations at 100 million instructions per second (mips).

The chips conform to IEEE standards for arithmetic. The multiplier chip also does double-precision divides and square roots somewhat more slowly than multiplies (180 and 325 nanoseconds, respectively, versus 45 nanoseconds for the multiply). Other IEEE operations, such as exponentiation, logarithms, and trigonometric functions, would have to be flagged as exceptions and handed off to another coprocessor, just as the Weitek chips now hand these operations off to a 68881 in the Sun workstations. Otherwise, they would have to be handled in firmware.

... continued on page 64

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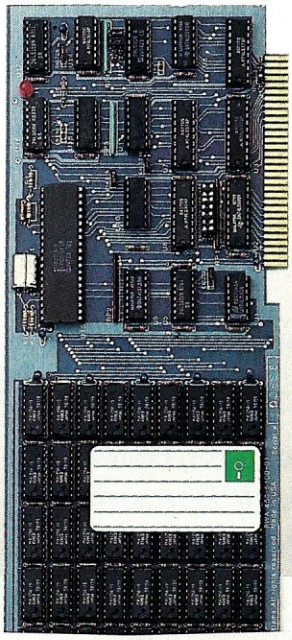

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Continued from page 62

I would love to have a coprocessor board that uses the BIT chips. Unfortunately, that is for some time in the future. It is a somewhat daunting task to go from the 25-MHz coprocessor boards available today to the 100-MHz boards that will run the BIT chips. The interface to a relatively slow bus, such as the AT bus or the VME bus for Sun workstations, will be a tricky one. One wonders if some sort of buffering hardware would improve this interface. Then there is the problem of getting the appropriate software implemented for the system—the fact that it will be a scalar processor may simplify this. For the moment, we can only note that the hardware basis for a true supercomputer on a desktop now exists.

Obviously, a particularly critical element will be the on-board RAM. It is generally true that, for scientific and technical work, the faster the processor, the larger the memory size required. Yet when one needs very small cycle times and memory random access times, it tends to be the case that more expensive fabrication techniques are required using more costly materials, and the resulting memory capacities of the chips are reduced. The combination of larger memory needs and smaller chip capacities translates into high costs. Obviously, a very efficient caching arrangement will be important.

One cannot help wondering whether the techniques that have enabled such a fast scalar machine to be built might not be applied to build a vector machine with pipelining. A 45-nanosecond, double-precision multiply clearly takes about 5 clock cycles at 100 MHz. That is comparable to the situation in the Weitek XL-Series chips, where a new multiply can start nearly every clock cycle. A peak vector performance approaching 200 mflops might thus result.

It is extremely exciting to think that machines with this level of performance are likely to be available some time in the 1990s. They will certainly transform scientific and technical number-crunching, and I look forward to personal benefits from that. But many other technical benefits will also occur. Consider the effect on graphics, for example. One should be able to generate computer movies in real time (but only by upgrading display systems to use much larger bandwidths). Scientific computations are increasingly relying on sophisticated displays to enable the programmer to understand what is going on in a complicated calculation.

Thus, even though the scientific number cruncher always feels inadequately supplied with what he calls "REAL*8" operations, the time is swiftly approaching when the performance of all the other parts of the system must be upgraded along with the mflops performance. □

A. G. W. Cameron is Professor of Astronomy at the Harvard-Smithsonian Center for Astrophysics.

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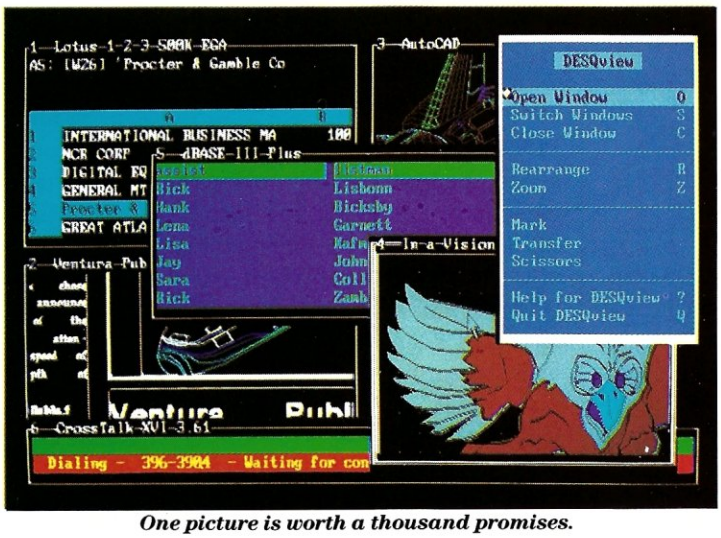

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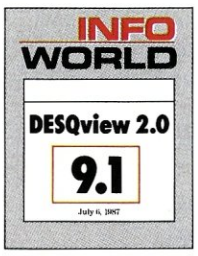

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Charles H. Strom

A DOS Enhancement and Powerful Printer Utility

Another year of DOS-compatible public domain and shareware software is upon us. And the first software we'll look at is Norm Patriquin's PPRINT, version 3.1, current as of this writing.

PPRINT

PPRINT is user-customizable so it can be used with virtually any printer. Although a number of printer definition files are included in the shareware distribution, full instructions are provided for constructing PPRINT.DEF files. Support of the Hewlett-Packard LaserJet is an unusual plus. Some of the commands supported include font control, multiple copies, variable spacing, and a wildcard facility with printing based on file dates (for example, only those files that have date stamps newer than five days ago are printed). Also included are headers and footers, special formatting for C-source programs, multiple-space compression, variable margins, and so on. The list of options is a little overwhelming, but as Patriquin points out, batch files can be used conveniently since everything is command-line driven.

Norm Patriquin distributes PPRINT through the shareware principle—try it for free and register the program for $15 (registration only) or $30 (registration, disk and manual) if it satisfies your needs. PPRINT is but one of Norm's creations, and I will probably be discussing others in the coming months. PPRINT and other Patriquin utilities are available through his own BBS at (714) 369-9766 (modem), on GEnie's IBM RoundTable, and on many bulletin board systems.

Command Plus

Have you ever wondered why DOS's COMMAND.COM can be replaced with an alternative command shell? I finally found the answer in Command Plus, a useful (and as far as I can determine, the only) alternative to COMMAND.COM. Command Plus, by ESP Software Systems (11965 Venice Blvd., Ste. 309, Los Angeles, CA 90006) is not public domain or shareware, but it is low in cost. It retails for $79.95 and is available for a discount from The Programmer's Connection. Call them at (800) 336-1166.

Command Plus is a complete replacement for COMMAND.COM. No learning is necessary, as all the familiar DOS commands are used. It can be run under Versions 2.x or 3.x of DOS by simply invoking it as a TSR (terminate-and-stay-resident program) or under 3.x with the Shell command to completely replace COMMAND.COM.

Command Plus's enhancements over standard DOS include several features for which I previously used add-ons discussed in earlier columns, such as CED and LIST. For example, there is a command buffer scrolled through with the cursor up and down arrows. Alternatively, a History command presents the command buffer in a numbered list. There is a full command-line-editing capability as well. Several of the familiar commands are greatly enhanced. DIR, for example, allows sorting by date, time, name, size, and extension. The long form of the command displays file attributes; hidden files can be displayed; and so on. The Copy command has expanded selection criteria, such as date/time ranges, verification before copy, and others. Similarly, the DELete function is more useful than its DOS ancestor.

Command Plus includes many other capabilities as well. An Alias command can generate RAM-resident batch files, modify the default options of any command, and so on. Browse is similar in usage to Vern Buerg's List, although it is not as rich in options. A Log facility allows automatic or manual tracking of machine usage for such purposes as billing, IRS certification, and others. Finally, ESP includes Script, an interpretive command processor similar in concept to Batch but much more powerful. Script files may call other scripts, but are limited to 10 levels of nesting. Each script file can access up to five each of integer, long integer, and string variables. Operators include comparisons (less than, equal, greater than or equal to, and so on), Booleans (NOT, AND, OR), arithmetics, conditionals, and others. BEGIN . . . END and CASE . . . ENDCASE constructs, FOR loops, IF . . . ELSE, and so on are also included. It is not necessary to go into further detail to see that SCRIPT offers great functionality to those willing to tap its power.

That's it for this month. Keep those cards and letters coming, and please upload your favorite public domain and shareware programs to the GEnie IBM RoundTable so I can get a chance to take a look at them! □

Charles Strom is a chemist-in-training who has been working with microcomputers for more than 10 years. He is a sysop on the GEnie national time-sharing service.

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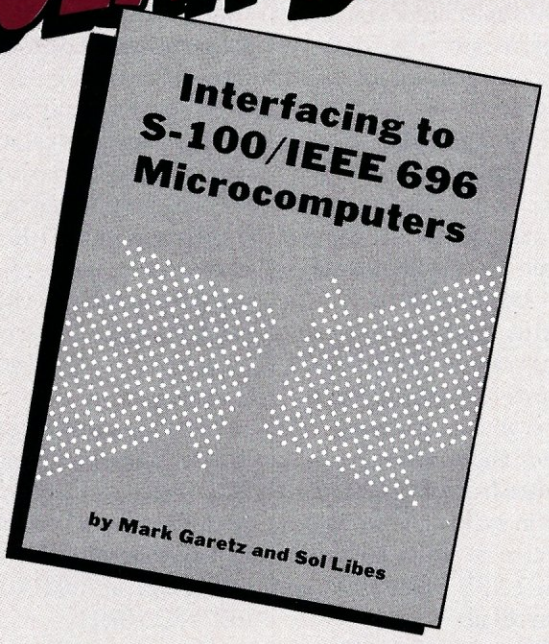

Interfacing to S-100/IEEE 696 Microcomputers by Mark Garetz and Sol Libes

Interfacing to S-100/IEEE 696 Microcomputers provides an in-depth look at how the S-100 bus works, and includes concepts that are basic to the understanding of most any bus-based system. You'll find:

- a precise description of the mechanical and functional design of the S-100 bus
- logical and electrical relationships
- bus interconnections and busing techniques
- descriptions of both parallel and serial interfacing as well as interfacing to RAM, ROM, and the real world
- a discussion of digital-to-analog and analog-to-digital conversion
- interrupts
- programmable timer/counters
- temporary master access and temporary bus masters
- and useful circuits.

While the examples contained in ***Interfacing to S-100/IEEE 696 Microcomputers*** relate specifically to the S-100 bus, the concepts presented can help you to expand the utility and power of any bus based system.

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New Products

Manufacturers who would like to have their products listed here should send their news releases to the Managing Editor, Micro/Systems Journal, *501 Galveston Drive, Redwood City, CA 94063.*

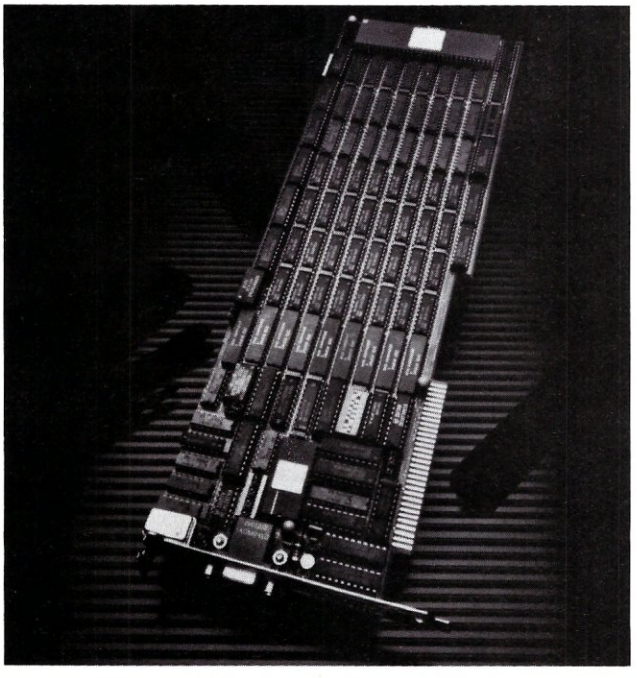
PC-Compatible Products

Special Offer for AutoCAD Board

Control Systems, Inc., has introduced the Artist 10, a high-performance graphics controller based on the Hitachi CRT controller IC to enhance AutoCAD version 9.0 on PCs. The board offers 1024 × 768 non-interlaced or 1024 × 1024 interlaced resolution with 16 or 256 displayable colors from a palette of 262,144 colors. The board is compatible with the IBM PC, XT, and AT and operates in concert with Control Systems' Artist GT, a software interlace option that works with system EMS memory to speed redraws and provide bird's-eye-view windows and multiple views.

To promote the Artist 10, Control Systems will offer an upgrade program through March 31. Targeted for customers using the Artist family of boards, qualified participants can return their old boards to Control Systems with a cashier's check and an upgrade certificate from their dealer and in exchange they will receive an Artist 10 board for $1,995, $1,000 less than retail.

For more information, contact Control System, 2675 Patton Rd., St. Paul, MN 55113; (612) 631-7800.



The Artist 10 from Control Systems, Inc.

386 Accelerator Now Available for PC and XT

Applied Reasoning Corporation has begun delivery of a 386 plug-in accelerator board for IBM or compatible computers. The PC-Elevator 386 comes with disk cache, RAM disk, and EMS support and runs an Intel 80386 processor at 16 MHz (no wait states) with a 32-bit bus. The board includes one megabyte of RAM operating at 100 nanoseconds, and is expandable to 16 MB with daughter cards. The company rates the board at 3.4 mips.

The PC-Elevator 386 lists for $1,995. For more information, contact Applied Reasoning Corporation, 86 Sherman St., Cambridge, MA 02140; (617) 492-0700

Other Hardware Products

Astrocom Gets AT&T Approval for Multiplexer

Astrocom Corporation has unveiled its 8000 Subrate Data Multiplexer, which is compatible with AT&T's ABC service. The SDM Series 8000 is a multiple-port, synchronous, time division multiplexer with an internal DSU/CSU. Modular design allows the user to customize the hardware required to create a specific application configuration providing capability and flexibility beyond that outlined in publication 54075. The multiplexer has modular expansion for 5-10-15-20 primary user ports and synchronous port speeds of 2.4 to 19.2K bps. It also has asynchronous secondary channels for network management and diagnostics; front-panel LCD command screen and control switches for data rate selection, configuration, and diagnostics; and a supervisory port to provide end-to-end network management functions such as network status, test initiation, and diagnostics.

The five-port unit sells for $3,350. For more information about the SDM Series 8000, contact Astrocom Corporation, 120 W. Plato Blvd., St. Paul, MN 55107; (612) 227-8651.

MSI Adds Two Multiplexers

Method Systems Inc. (MSI) has added two new multiplexers to its data communications line, the Mini Mux and the Mighty Mux. Both multiplexers have internal jumpering for easy modification providing options for transmission distances of one, two, and three miles (with some bit rate loss at longer distances). The Mini Mux operates at data rates up to a maximum of 9.9 kbits/sec., with receive/transmit lines for each of it eight channels. The Mighty Mux offers independent data rates of up to 119.2 kbits/sec. per channel, and each channel has a receive, transmit, CTS/RTS, or DTR/DCD line accommodating hardware handshake. Both units

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PC Magazine
Dec. 22, 1987

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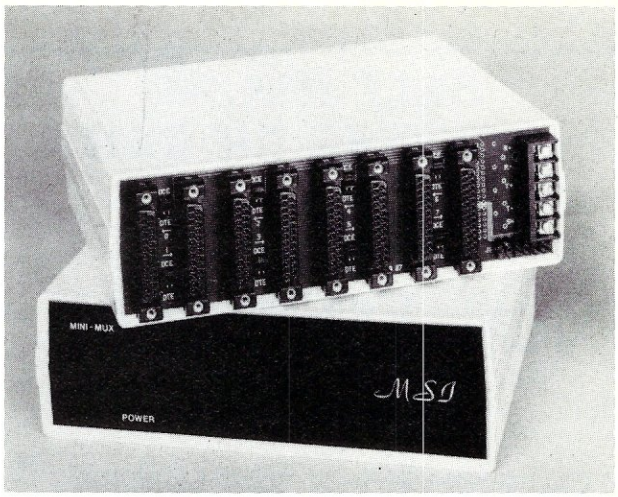

The Mini-Mux from MSI

have eight channels; ports setable for DCE/DTE configuration; common-channel, four-wire twisted pair; and external power supplies.

The Mini Mux retails for $395 and the Mighty Mux is $495. For more information, contact Method Systems Inc., 3511 Lost Nation Rd., Willoughby, OH 44094; (800) 533-6116, (216) 942-2100.

New Software Products

New FORTRAN Supports 386

Science Applications International Corporation (SAIC) has released SVS FORTRAN-386 for the Compaq Deskpro 386 and compatible computers. SVS FORTRAN-386 allows users to develop large FORTRAN programs (up to 16 MB) and run them in 386 protected mode under control of existing DOS 2.x or 3.x. It also features a native code compiler, a complete runtime I/O system, a source-level debugger, and a VM/RUN 386 runtime monitor. SVS FORTRAN-386 provides full support of Intel 80287/80387 and Weitek 1167 math coprocessors.

SVS FORTRAN-386 is priced at $895, including the source-level debugger and the VM/RUN runtime monitor. For more information, contact SAIC, 5150 El Camino Real, Ste. C-31, Los Altos, CA 94022; (415) 960-5931.

Accurate Quick Basic-to-C Translation

Software Translations, Inc., (STI) has released B-Tran, a Quick Basic-to-C source code translator. B-Tran delivers fast, clean C code from applications written in Microsoft Quick Basic with 11 percent greater speed and more flexibility. Suitable for use with Microsoft, Lattice, and Borland C development systems, the translator is guaranteed 97-percent efficient and can integrate with other C libraries.

B-Tran is priced at $495, and a demonstration disk and manual are available for $25. For more information, contact Software Translations, Inc., 28 Green St., Newburyport, MA 01950; (617) 462-5523. □

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Robert Lerche, Bay Partners.

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Robert Wenig, Autodesk.

"Our software is running anywhere from 30 to 50% faster than when compiled under Lattice." **David Marcus, Micronetics.**

"We switched from Lattice due to a 10% reduction in code size. The compiler is very stable." **Lee Lorenzen, Ventura Software — Ventura Publisher, marketted by Xerox Corp.**

"Best quality emitted code by any compiler I've encountered. Often amazing." **Bill Ferguson, Fox Software — FoxBase (386).**

"Messages sometimes pointed out type mismatches, incorrect-length argument lists, and uninitialized variables that had been undetected for years [in 4.x bsd]." **Larry Breed, IBM ACIS [RT PC].**

"Diagnostics turned up bugs missed by other compilers. Rapid bug fixes by technical support, someone who knew what he was talking about. 80386 code is well optimized."
Tim Addison, Logistics Data Systems.

"386 protected mode support is fantastic, especially the access to large amounts of memory. It's mainframe compute power on a PC." **Dan Eggleston, Viewlogic.**

"The preprocessor supplied with Professional Pascal is quite useful. The code quality and control over segmentation and memory models are superior to MS Pascal." **Bob Wallace, QuickSoft.**

Check Out These Reviews

- **High C ™:**

Computer Language	February 1986, '87	
Dr. Dobb's Journal	August 1986	
PC Magazine	Jan. 27, 1987	(80386 version)
Dr. Dobb's Journal	July 1987	(80386 version)
BYTE Magazine	November 1987	(80386 version)

- **Professional Pascal ™:**

PC Magazine	Dec. 29, 1985	
Computer Language	May 1986	
PC Tech Journal	July 1986	
Journal of Pascal, Ada, & Modula-2	Nov.-Dec. 1986	
BYTE Magazine	Dec. '86, June '87	(80386 version)

Why MetaWare compilers

- They are specifically designed for serious software developers.
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- You can benefit from high-level, personal technical support.
- You can take advantage of the latest ANSI C extensions, and/or extensive Pascal extensions. **High C** has been tracking the ANSI Standard for two years; **Professional Pascal** will soon have a VS Pascal compatibility switch and several Apollo Pascal ext'ns.
- You can take advantage of the latest 387 and Weitek 1167 support — we have the only compilers with Weitek real mode support.

Power Tools for Power Users

Ashton-Tate: dBase III Plus, MultiMate; Autodesk: AUTOCAD, AUTOSKETCH (8087, '387, Weitek); Boeing Computer Services (Sun); CASE Technology (Sun); CAD/CAM giant Daisy ('86, '386, VAX); Deloitte Haskins & Sells; Digital Research: FlexOS; GE; IBM: 4.3/RT, 4680 OS; Lifetree Software (Pascal): Volkswriter Deluxe, GEM-Write; Lugaru: Epsilon; NYU: Ada-Ed cmplr; Semantec: Q&A; Sky Computers; … (Product names are trademarks of the companies indicated.)

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MetaWare C and Pascal compilers are designed for professional software developers. These tools are loaded with options to control them for special purposes. You can adjust the space-time trade-off in code quality. You can adjust external naming conventions to agree with linkers and operating systems. You can specify segment names for segmented architectures, and to help place code or data in particular places for embedded applications. You can select from five memory models for the 8086 family. And on and on.

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"Platform" — Code Quality

Sun,Apollo,SGI	— 18%, 3%, 26% > resident compiler (Dhrystone).
PC: DOS, OS/2	— 3-10% > Microsoft C; 30% > MS Pascal, LatticeC.
386 32-bit DOS	— no competitors, since November, 1986.
286, 386 UNIX	— 66% better than pcc (Dhrystone, 386).
VAX VMS	— ≈ DEC's excellent C and Pascal; better features.
VAX Ultrix	— 19% > pcc (Dhrystone); much > Berkeley Pascal.
RT PC/4.3bsd	— 89% > the original port of pcc (Dhrystone).
370 CMS,UNIX	— much better than any C, and VS Pascal.
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All the computer listings printed in *Micro/Systems* are available on MS-DOS floppy disk. Programs from each issue are available for $14.95 each. For more information, contact:
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(415) 366-3600, ext. 221

Kaypro/Osborne CP/M mouse driver, $40, faster and easier cursor movement in WordStar, SuperCalc, graphics, etc. Progressive Products, (408) 265-5490, 1797 Nelson Way, San Jose, CA 95124.

SQL.PAS
Make stack, queue, and list standard data types in Turbo Pascal ($9.95). PSW, Box 10072, McLean, VA 22102-8072.

WE WELCOME YOUR ARTICLES

We are always glad to hear from potential authors who have an interesting tale to tell. If you are interested in contributing an article that relates to local area networks, multiuser systems, or computer programming, please contact us. For example, in upcoming issues we plan to discuss:

- PC Multiuser Operating Systems
- UNIX on the PC
- Graphics on the PC
- 386 Software Development Tools
- Database Options
- Troubleshooting Local Area Networks
- Modem Standards and Compatibility
- High-Capacity Information Storage

We would welcome your contributions on these and related topics. Please contact:

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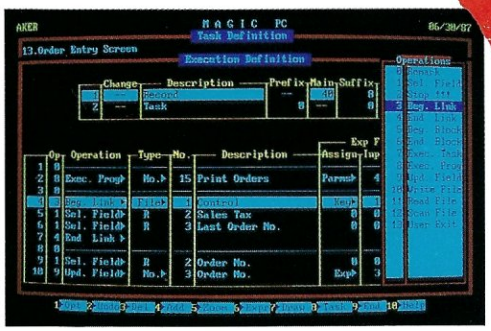
MAGIC PC: A REVOLUTION IN POWER, PRICE & PROGRAMMING SPEED.

You know how database applications are created — by hacking out line after line of time-consuming code. Most DBMS' and 4GL's give you some programming power. But when it comes to serious applications, they keep you bolted to your seat writing mountains of tedious code. And rewriting it all over again with every design change.

Imagine how much faster you'd be if you could replace the painful coding phase with an innovative visual technology which takes only a fraction of the time: Introducing Magic PC—the revolutionary Visual Database Language from Aker Corporation:

High-Speed Programming:

With Magic PC's visual design language you quickly describe your programs in non-procedural Execution Tables. They contain compact programming operations which are executed by Magic PC's runtime engine. You fill-in the tables using a visual interface driven by windows and point-and-shoot menus. One table with 50 operations eliminates writing more than 500 traditional lines of code. Yet with Magic PC you don't sacrifice any power or flexibility.



With a powerful set of high-level non-procedural operations you program at only a fraction of the time.

Maximum Power AND Simplicity:

With Magic PC, you can generate robust DBMS applications including screens, windows, menus, reports, forms, import/export, and much more! Plus, Magic PC has one of the friendliest user interfaces you've ever seen. Using Magic PC you can look-up and transfer data through a powerful Zoom Window system. Magic PC even lets you perform command-free queries.

Btrieve Performance:

Magic PC incorporates Btrieve, the high-performance file manager from SoftCraft. This gives you exceptional access speed, extended data dictionary capabilities, and automatic file recovery!

Virtually Maintenance-Free:

With Magic PC you can modify your application design "on the fly" without any manual maintenance. Magic PC automatically updates your programs and data files on-line! This also makes Magic PC an ideal tool for prototyping complete applications in hours instead of days.

FREE Networking:

Magic PC comes complete with LAN features. Develop multi-user applications for your LAN with Magic's file and record-locking security levels.

Stand-Alone Runtime:

Distribute your applications and protect your design with Magic PC's low cost runtime engine.

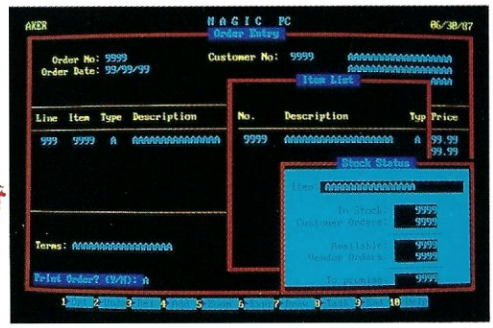
All For Only $199:

Best of all, Magic PC is an unbeatable bargain. For a limited time, Magic PC's price has been reduced to only $199! Yes, this is the same Magic PC that normally lists for $695! And Magic PC *eliminates the need for a separate DBMS, compiler, or application generator. It comes complete with all the tools you need* to develop your own database applications instantly.

$199 – With A Money-Back Guarantee!

For a limited time, you can get Magic PC for only $199. And even at this low price, Magic PC is risk-free. If you're not completely satisfied, simply return it within 30 days and we'll buy it back (less $19.95 restocking fee). And if you'd like a preview, Magic PC's Tutorial Demo is available for just $19.95.

But you'd better hurry – Magic PC's special $199 price won't last long!



Pop-up Zoom Windows run multiple programs per screen — with point-and-shoot data transfer between windows!

Join The Magic PC Revolution

To unleash your DBMS design power, order your $199 copy of Magic PC right now by calling toll-free or returning the coupon below.

ORDER NOW: CALL (800) 345-MAGIC

In CA (714) 250-1718

"Magic PC's data base engine delivers powerful applications in a fraction of the time. . . there is truly no competitive product."

Victor Wright – PC Tech Journal

Also recommended by: *PC Magazine, PC World, PC Week, Computer Language, Data Base Advisor,* and many other publications worldwide.

MAGIC PC
The Visual Database Language
by AKER

Yes! I want to generate powerful applications much faster!

☐ Rush me my copy of Magic PC at the special promotional price of $199 (add $10 P&H, and tax in CA. International orders add $30). I understand I can return Magic PC for a refund within 30 days, if I'm not completely satisfied.*

☐ Rush me a copy of Magic PC Tutorial Demo at $19.95 (add $5 P&H, and tax in CA. International orders add $15).

Name _____

Company _____

Street Address (no POB) _____

City _____ State _____ Zip _____

☐ Check enclosed Charge to my: ☐ VISA ☐ ☐ AMERICAN EXPRESS

Account No. _____

Acct. Name _____ Exp. Date ____/____

Signature _____

Return to: **Aker Corp.,** *18007 Skypark Cir B2, Irvine, CA 92714*

MS

System requirements: IBM PC, XT, AT, PS/2 or 100% compatible with 512K RAM, hard disk and DOS 2.0 or later. 5¼" format, not copy protected. Dealer pricing available. *Return policy valid in US only.

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How A C Programmer Became A Screen Star

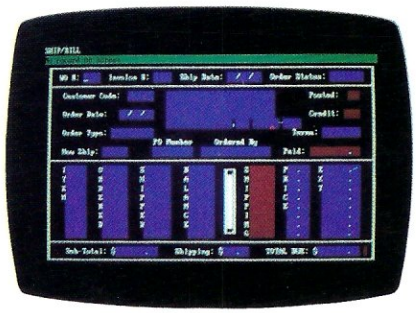
Screens, the Visible Part of Your Program.

A program is often judged by how well the screens are executed. However, the real creativity lies in what goes on behind the screens.

ScreenStar is a product that allows your real creativity to light up the screen. It reduces costly screen, window, and data validation development time.

You Take the Bows, We Write the Code.

Our natural drawing commands allow you to paint any screen imaginable. Press one key when you are satisfied and ScreenStar produces concise, commented, ready-to-compile code. This allows immediate testing of the I/O screens, including smooth, even scrolling between multiple screens.



Create or capture complex screens with data-entry filters built in.

If all ScreenStar did was turn screens into code it would be a useful tool. Yet ScreenStar also permits a wide range of field types. Some of the choices include date, alphanumeric, telephone, yes/no, dollar, time and user-definable fields.

Other valuable data-entry filters are built in, such as required field, display only, and many others. All screen fields are generated with error-checking routines.

ScreenStar Not Only Captures Your Imagination, It Captures Screens.

The memory-resident capture program converts any screen into a ScreenStar file in seconds, including those generated by programs like Dan Bricklin's Demo Program.

ScreenStar Sets the Stage for Windows.

ScreenStar comes with a complete window generating library. You design the help screens and pop-up windows. Essential ScreenStar windowing functions tie them together in one smooth package.

Curtain Call.

They may not ask for your autograph, but they will want to know how you did those screens. Screenstar is more than a screen-painting program. It is a screen processor. No professional programming environment will be complete without this product.

We know you will enjoy using ScreenStar. However, should you give it less than rave reviews, return it within 30 days for a full refund.

★ Interactive screen painting and subsequent code generation.

★ Multiple screen design and scrolling.

★ TSR screen capture program, works with any program including Dan Bricklin's Demo Program.

★ Complete window design including overlapping window functions.

★ Screens are compressed into data structures, and remain a permanent part of the program. No messy data files to look for.

Price - $99

W/Source add $99

Audition Our Product Today. Call:

(201) 762-6965

Essential Software
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South Orange, NJ 07079

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